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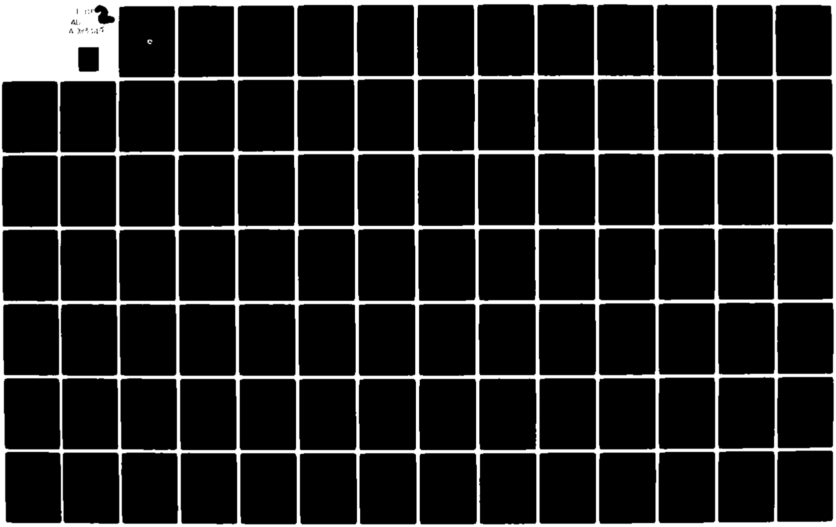

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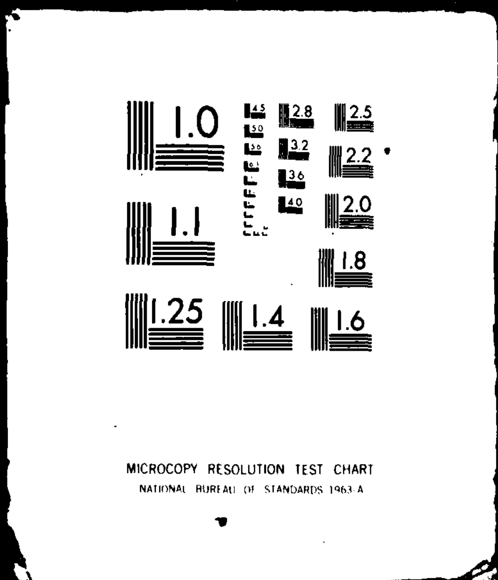

FAA-RD-80-91

MLS CHANNEL ASSIGNMENT MODEL

Thomas Hensler and Andrew Koshar
of
IIT Research Institute
Under Contract to
DEPARTMENT OF DEFENSE
Electromagnetic Compatibility Analysis Center
Annapolis, Maryland 21402

AUGUST 1980

Interim Report

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Systems Research & Development Service
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16. Abstract

An automated channel assignment model was constructed in response to an FAA need to assess the assignment feasibility of planned MLS angle-guidance equipment in C-band, and its associate L-band Precision Distance Measurement Equipment (PDME). The intersite interference analysis and channel-assignment algorithm capabilities are described. A trial assignment of MLS equipments was performed for a Southwest United States airport environment and the results are summarized.

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PREFACE

The Electromagnetic Compatibility Analysis Center (ECAC) is a Department of Defense facility, established to provide advice and assistance on electromagnetic compatibility matters to the Secretary of Defense, the Joint Chiefs of Staff, the military departments and other DoD components. The center, located at North Severn, Annapolis, Maryland 21402, is under policy control of the Assistant Secretary of Defense for Communication, Command, Control, and Intelligence and the Chairman, Joint Chiefs of Staff, or their designees, who jointly provide policy guidance, assign projects, and establish priorities. ECAC functions under the executive direction of the Secretary of the Air Force and the management and technical direction of the Center are provided by military and civil service personnel. The technical operations function is provided through an Air Force sponsored contract with the IIT Research Institute (IITRI).

This report was prepared for the Systems Research and Development Service of the Federal Aviation Administration in accordance with Interagency Agreement DOT-FA70WAI-175, as part of AF Project 649E under Contract F-19628-78-C-0006, by the staff of the IIT Research Institute at the Department of Defense Electromagnetic Compatibility Analysis Center.

To the extent possible, all abbreviations and symbols used in this report are taken from American Standards Y10.19 (1967) "Units Used in Electrical Science and Electrical Engineering" issued by the USA Standards Institute.

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ENGLISH/METRIC CONVERSION FACTORS

LENGTH

From \ To	cm	m	km	in	ft	mi	nmi
cm	1	0.01	1×10^{-5}	0.3937	0.0328	6.21×10^{-6}	5.39×10^{-6}
m	100	1	0.001	39.37	3.281	0.0006	0.0005
km	100,000	1000	1	39370	3281	0.6214	0.5395
in	2.540	0.0254	2.54×10^{-5}	1	0.0833	1.58×10^{-5}	1.37×10^{-5}
ft	30.48	0.3048	3.05×10^{-4}	12	1	1.89×10^{-4}	1.64×10^{-4}
mi	160,900	1609	1.609	63360	5280	1	0.8688
nmi	185,200	1852	1.852	72930	6076	1.151	1

AREA

From \ To	cm^2	m^2	km^2	in^2	ft^2	mi^2	nmi^2
cm^2	1	0.0001	1×10^{-10}	0.1550	0.0011	3.86×10^{-11}	5.11×10^{-11}
m^2	10,000	1	1×10^{-6}	1550	10.76	3.86×10^{-7}	5.11×10^{-7}
km^2	1×10^{10}	1×10^{6}	1	1.55×10^{3}	1.08×10^{7}	0.3861	0.2914
in^2	6.452	0.0006	6.45×10^{-10}	1	0.0069	2.49×10^{-10}	1.88×10^{-10}
ft^2	929.0	0.0929	9.29×10^{-8}	144	1	3.59×10^{-8}	2.71×10^{-8}
mi^2	2.59×10^{10}	2.59×10^{6}	2.590	4.01×10^{9}	2.79×10^{7}	1	0.7548
nmi^2	3.43×10^{10}	3.43×10^{6}	3.432	5.31×10^{9}	3.70×10^{7}	1.325	1

VOLUME

From \ To	cm^3	liter	m^3	in^3	ft^3	yd^3	fl. oz.	fl. pt.	fl. qt.	gal.
cm^3	1	0.001	1×10^{-6}	0.0610	3.53×10^{-5}	1.31×10^{-6}	0.0338	0.0021	0.0010	0.0002
liter	1000	1	0.001	61.02	0.0353	0.0013	33.81	2.113	1.057	0.2642
m^3	1×10^{6}	1000	1	61,000	35.31	1.308	33,800	2113	1057	264.2
in^3	16.39	0.0163	1.64×10^{-5}	1	0.0006	2.14×10^{-5}	0.5541	0.0346	2113	0.0043
ft^3	28,300	28.32	0.0283	1728	1	0.0370	957.5	59.84	0.0173	7.481
yd^3	765,000	764.5	0.7646	46700	27	1	25900	1616	807.9	202.0
fl. oz.	29.57	0.2957	2.96×10^{-5}	1.805	0.0010	3.87×10^{-5}	1	0.0625	0.0312	0.0078
fl. pt.	473.2	0.4732	0.0005	28.88	0.0167	0.0006	16	1	0.5000	0.1250
fl. qt.	948.4	0.9463	0.0009	57.75	0.0334	0.0012	32	2	1	0.2500
gal.	3785	3.785	0.0038	231.0	0.1337	0.0050	128	8	4	1

MASS

From \ To	g	kg	oz	lb	ton
g	1	0.001	0.0353	0.0022	1.10×10^{-6}
kg	1000	1	35.27	2.205	0.0011
oz	28.35	0.0283	1	0.0625	3.12×10^{-5}
lb	453.6	0.4536	16	1	0.0005
ton	907,000	907.2	32,000	2000	1

TEMPERATURE

$$°C = 5/9\ (°F - 32)$$
$$°F = 9/5\ (°C) + 32$$

FAA-RD-80-91

FEDERAL AVIATION ADMINISTRATION
SYSTEMS RESEARCH AND DEVELOPMENT SERVICE
SPECTRUM MANAGEMENT STAFF

STATEMENT OF MISSION

The mission of the Spectrum Management Staff is to assist the Department of State, Office of Telecommunications Policy, and the Federal Communications Commission in assuring the FAA's and the nation's aviation interests with sufficient protected electromagnetic telecommunications resources throughout the world to provide for the safe conduct of aeronautical flight by fostering effective and efficient use of a natural resource--the electromagnetic radio-frequency spectrum.

This objective is achieved through the following services:

- Planning and defending the acquisition and retention of sufficient radio-frequency spectrum to support the aeronautical interests of the nation, at home and abroad, and spectrum standardization for the world's aviation community.

- Providing research, analysis, engineering, and evaluation in the development of spectrum related policy, planning, standards, criteria, measurement equipment, and measurement techniques.

- Conducting electromagnetic compatibility analyses to determine intra/inter-system viability and design parameters, to assure certification of adequate spectrum to support system operational use and projected growth patterns, to defend the aeronautical services spectrum from encroachment by others, and to provide for the efficient use of the aeronautical spectrum.

- Developing automated frequency-selection computer programs/routines to provide frequency planning, frequency assignment, and spectrum analysis capabilities in the spectrum supporting the National Airspace System.

- Providing spectrum management consultation, assistance, and guidance to all aviation interests, users, and providers of equipment and services, both national and international.

EXECUTIVE SUMMARY

The Federal Aviation Administration (FAA) has requested that the Electromagnetic Compatibility Analysis Center (ECAC) provide a channel-assignment model capable of making channel assignments for the new Microwave Landing System (MLS). The MLS consists of angle-guidance equipments operating in C-band and its associated Precision Distance Measurement Equipment (PDME) operating in L-band. It was desired that the model be capable of using various channel-separation criteria and assignment environments input by the user. It was also necessary that the model should assign equipments according to a user-input channelization scheme and be capable of pairing MLS and PDME channel assignments with existing TACAN/DME and VOR/ILS channels. The results of an assignment will be a list of the airport runways in the environment, the channel assigned to each runway, and an indication of which equipment contributed most to the failure of any runway to get a channel assigned.

The channel-assignment model consists of an intersite analysis routine and a channel assignment routine. The intersite analysis routine calculates desired-to-undesired signal power ratios (D/U) within each equipment's protected service volume. It then constructs an array containing the worst-case D/U value which exists between each pair of equipments in the environment.

The channel-assignment routine converts the worst-case D/U values to channel separation between equipments, and makes channel assignments that satisfy these separation requirements. The channel assignments are performed using a dynamic assignment technique in which the most difficult assignments (those with the least number of available channels) are attempted first. This routine includes an option allowing the user to specify the order of equipment assignment as he wishes, as an alternative to the dynamic technique.

A trial channel assignment of a Southwest U.S. airport environment using the dynamic ordering technique was made to test both the model and channel plan capability. This trial assignment is documented in the results section of this report.

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SECTION 1

INTRODUCTION

BACKGROUND

A new non visual precision approach and landing guidance system has been accepted by the International Civil Aviation Organization (ICAO)[1] as the future international standard.

The federal Aviation Administration (FAA) proposed Microwave Landing System (MLS), is based on the Time Reference Scanning Beam (TRSB) technique in which time between successive scans of narrow fan beams provide elevation and azimuth information to aircraft within a designated service volume. Distance information is provided by existing Distance Measurement Equipment (DME) or by new Precision Distance Measurement Equipment (PDME), both operating in L-band (960 to 1215 MHz). Current proposals call for channel pairing[a] between these L and C-band guidance functions. APPENDIX B contains a system description of the MLS angle-guidance and range-guidance equipments.

Early in the development of the MLS, the Electromagnetic Compatibility Analysis Center (ECAC) developed an automated channel assignment model that was capable of performing intersite analyses and making channel assignments for the MLS functions as they were envisioned in 1972[2]. Subsequent refinements to the MLS system design and implementation plans have resulted in a requirement for a more complex channel-assignment model.

[1] Time Reference Scanning Beam Microwave Landing System, DOT/FAA, December 1975.

[2] *Frazier, R., In-Band Compatibility Analysis of the RTCA-Proposed Microwave Landing Guidance System (LGS) and Interim System, (FAA-RD-75-62), ECAC, Annapolis, MD., July 1972.*

[a] Channel pairing is when frequency assignments in different bands are interdependent. This enables a pilot to automatically use equipments of different bands by tuning to a single channel.

One of the major changes is that the PDME function has been moved from C-band (5.0-5.25 GHz) to L-band (960 to 1215 MHz). The current plan calls for possible assignment of the PDME function to existing L-band X and Y mode channels used by conventional DME systems. Additional L-band channels are expected to be created by defining new operating modes (i.e., multiplexing) on the present L-band frequency pairings.

The L-band TACAN/DME X and Y mode channels are currently channel paired to VHF (ILS Localizer and VOR) and UHF (ILS Glideslope) channels. Dependent upon the final implementation strategy, assigning the PDME functions to these L-band channels may result in channel-pairing of aeronautical radionavigation equipments in four bands: MLS angle-guidance equipment in C-band; TACAN, conventional DME and PDME equipments in L-band; ILS Localizer and VOR equipments in the VHF band; and ILS Glideslope equipments in the UHF band. Coupling between bands could therefore result in a need, when making MLS assignments, to check MLS C-band angle-guidance assignment criteria with potential assignment criteria in the L, VHF, and UHF bands.

In addition, the model reflects the FAA requirement that greater accuracy be provided in predicting the value and location point within the MLS protected service volume of the minimum desired-to-undesired signal power ratio (D/U).

OBJECTIVES

The objectives of this effort were to develop an automated channel-assignment model capable of providing frequency assignments of MLS equipments that operate either in C-band or L-band, and to provide a trial channel assignment predicated on a specific test environment and channelization scheme that utilizes existing VHF and UHF channels.

APPROACH

In developing an automated channel-assignment model (CAM), it was necessary that the CAM be capable of providing MLS frequency assignments that would allow operation on a non-interference basis of the new MLS equipments with the present airport and enroute equipments[3]. These combined environments include MLS angle-guidance equipment to be assigned to C-band channels; DME, PDME and TACAN range-guidance equipment in L-band; ILS localizer and VOR equipment in the VHF band; and ILS glideslope equipment in the UHF band.

To satisfy the need for an intersite analysis, as well as to provide channel assignments, two routines were developed. The intersite analysis routine was designed to calculate the minimum desired-to-undesired signal power ratio (D/U) within a desired facility's service volume. This analysis can be performed for either/or the sector/circular service volumes associated with ILS and MLS as well as the sector/circular service volumes of TACAN/DME and associated VOR equipments. The D/U ratios are calculated using equipment location and equipment characteristics obtained from the user-specified airport environment. Propagation loss predictions are provided by a model developed for the FAA by the Institute for telecommunications Sciences (ITS).[4] The intersite analysis results consist of predicted minimum D/U ratios for each equipment pair within the same frequency band.

The channel-assignment routine was designed to use the D/U values from the intersite analysis and convert them into minimum channel-separation requirements based on user-specified D/U protection criteria. Using these separation requirements and the frequency resources contained in a user-specified channel plan, a denied-channel array is generated. This array indicates those frequencies that are not available for use by each equipment to be assigned. If the user chooses the dynamic approach, a scan of the array determines the most constrained equipment, in terms of the remaining frequency resources available for its assignment.

---

[3] Analysis of MLS Channel Plans with L-Band DME, Inter-Agency Agreement, DOT-FA76WAI-6]2, Task Assignment.

[4] Gierhart, G.D. and Johnson, M.E., Propagation and Interference Analysis Computer Programs (0.1 to 20 GHz), Applications Guide, FAA-RD-77-60, ITS, Boulder, Colorado, March 1978.

The most constrained equipment is that which has the minimum number of available frequency resources. This equipment is assigned first. The denied-channel array is subsequently updated to include new constraints imposed by the channel just assigned, and the process is then repeated until all equipments are assigned or channel resources have been exhausted.

The channel-assignment model can assign equipments in each of the four bands (UHF, VHF, L-band, and C-band) and can make assignments for channel-paired equipments. Dependent upon user specified operating conditions it is also capable of reassigning existing preassigned[a] equipment if their present operating frequencies cannot satisfy the channel-separation requirements of the new channel paired MLS functions.

In addition to the development of the intersite analysis routine and the channel-assignment routine, it was necessary to identify the types of data required to support those routines during their use. These data are documented as part of the assignment system.

A trial assignment was made to appraise the assignment model's performance in a working environment, as well as the performance of an FAA-proposed equipment channelization scheme.

The environment used to test the assignment model was an updated Southwest U.S. airport environment that had been developed by the FAA in support of the Radio Technical Commission for Aeronautics Special Committee 117 (RTCA in 1972). This environment included a four-state area and is listed in APPENDIX D.

The differences between the 1972 environment and the present version are: 1) addition of MLS-PDME requirements to L-band; 2) addition of existing preassigned

[a]"Preassigned" refers to existing ILS/VOR or TACAN/DME equipments operating on a designated channel. When the new MLS and PDME systems are frequency paired to these existing equipments, their frequencies are predetermined in that the only MLS channel available for assignment is that which is hard-paired to the existing frequency assignment.

TACAN/DME and VOR enroute facilities, and existing preassigned ILS Localizer and Glideslope airport facilities to the UHF VHF-bands; and 3) addition of "dummy" equipments for the optional protection of paired frequencies where no associated equipments are physically installed.

The assignment was made using the channelization plan listed in APPENDIX E. The list of frequency resources that was used in this first trial channel assignment was derived by pairing the C-band Frequency Channel Plan with the L-band PDME Interim Channel Plan.[5] The assumptions used to derive the specific list of frequencies and to define the potential interdependence between the C-, L-, VHF and UHF bands are as follows:

1. C-band channels used for MLS angle-guidance were hard-paired to specific L-band channels. For example, C-band channel 002 (5031.6 MHz) was paired with L-band channel 18X (979 MHz). If either one of these channels was assigned to a facility, both of them were protected. If both could not be protected during the assignment process, neither could be assigned to that facility. This is repesentative of intrasystem hard pairing.

2. The existing channel-pairing required by ICAO Annex 10 between certain L-band channels, VHF channels, and UHF channels became part of the MLS channel plan. For example, channel 18X now pairs C-band (5031.6 MHz) with L-band (979 MHz), VHF-band ILS Localizer (109.10 MHz) and UHF-band ILS Glideslope (334.7 MHz) frequencies. As in (1) above, the assignment of any one of these frequencies at a facility requires the protection of all related hard paired frequencies, even though some of the equipment was not actually required. This is representative of intersystem hard pairing.

The protection criteria used in this first trial assignment is presented in APPENDIX C. Included in this appendix are some qualifying statements, and a listing of the criteria for all four frequency bands, i.e., C-band, L-band, and the VHF and UHF bands. It should be noted that consistent with traditional FAA procedure, only ground-to-air L-band interference interactions were considered.

[5] MLS Signal Format and System Level Functional Requirements, FAA-ER-700-08C, 10 May 1979.

SECTION 2

MODEL DESCRIPTION

INTRODUCTION

The MLS channel-assignment system was designed to provide MLS frequency assignments compatible with existing airport and enroute environments. The system was constructed in three parts, an intersite analysis, a channel-assignment model, and a supporting data base. The overall program flow is illustrated in FIGURE 1.

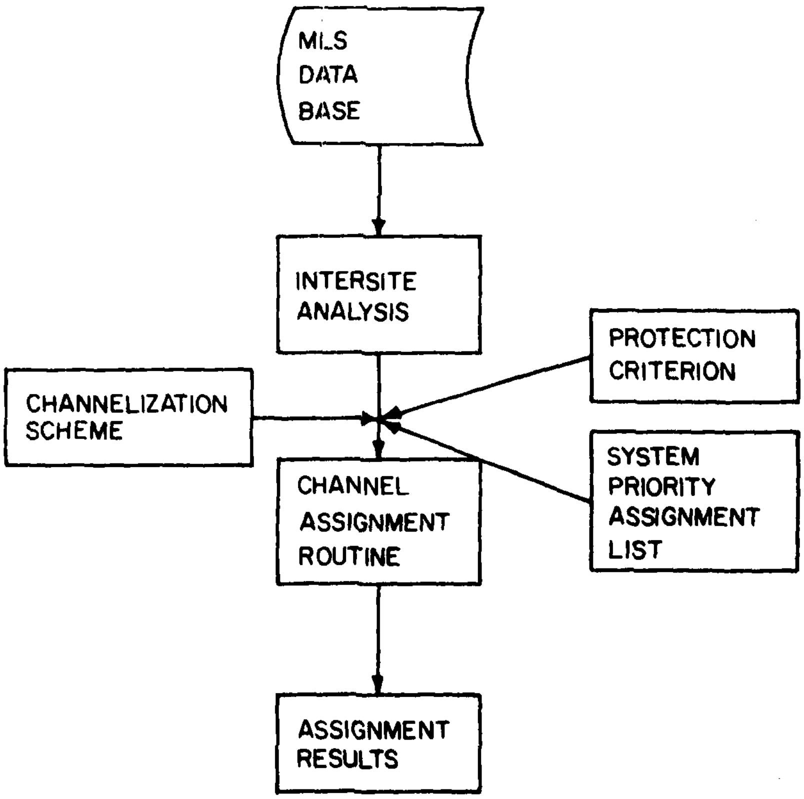

FIGURE 1. MLS CHANNEL ASSIGNMENT SYSTEM.

The system was designed so that the intersite routine and channel-assignment routine can be run independently. The results of the intersite analysis can be stored and reused for each assignment routine run. Hence it is generally not necessary to rerun the intersite analysis for each channel-assignment attempt.

A measure of the models usefullness during the MLS equipment development is its ability to accommodate various channelization schemes and assignment conditions that a user may wish to investigate. The flexibility to use varied schemes and conditions is accomplished through manipulating the model inputs (MLS data base, equipment protection criteria, channelization scheme, and equipment priority list) as well as selecting the use of several preprogrammed assignment options that control the internal assignment process. A discussion of the options and capabilities of the model that are available to the user is included in Section 3.

INTERSITE ANALYSIS

The intersite analysis routine examines the interference potential between two equipments and determines the minimum, i.e., worst-case, desired-to-undesired signal power ratio (D/U) at a receiver within the protected service volume of either equipment. The analysis is performed between equipments operating in the same frequency band.

The analysis has two parts, a distance culling procedure to identify those equipment pairs whose separation distance precludes interference, and a method for calculating the minimum D/U for the remaining equipment pairs. The intersite analysis program logic flow is shown in FIGURE 2.

Distance Cull

For each equipment pair, the model establishes two boundaries, a small circle defined by the victim service volume radius, and a larger circle representing the minimum distance separation for safe cochannel operation for the

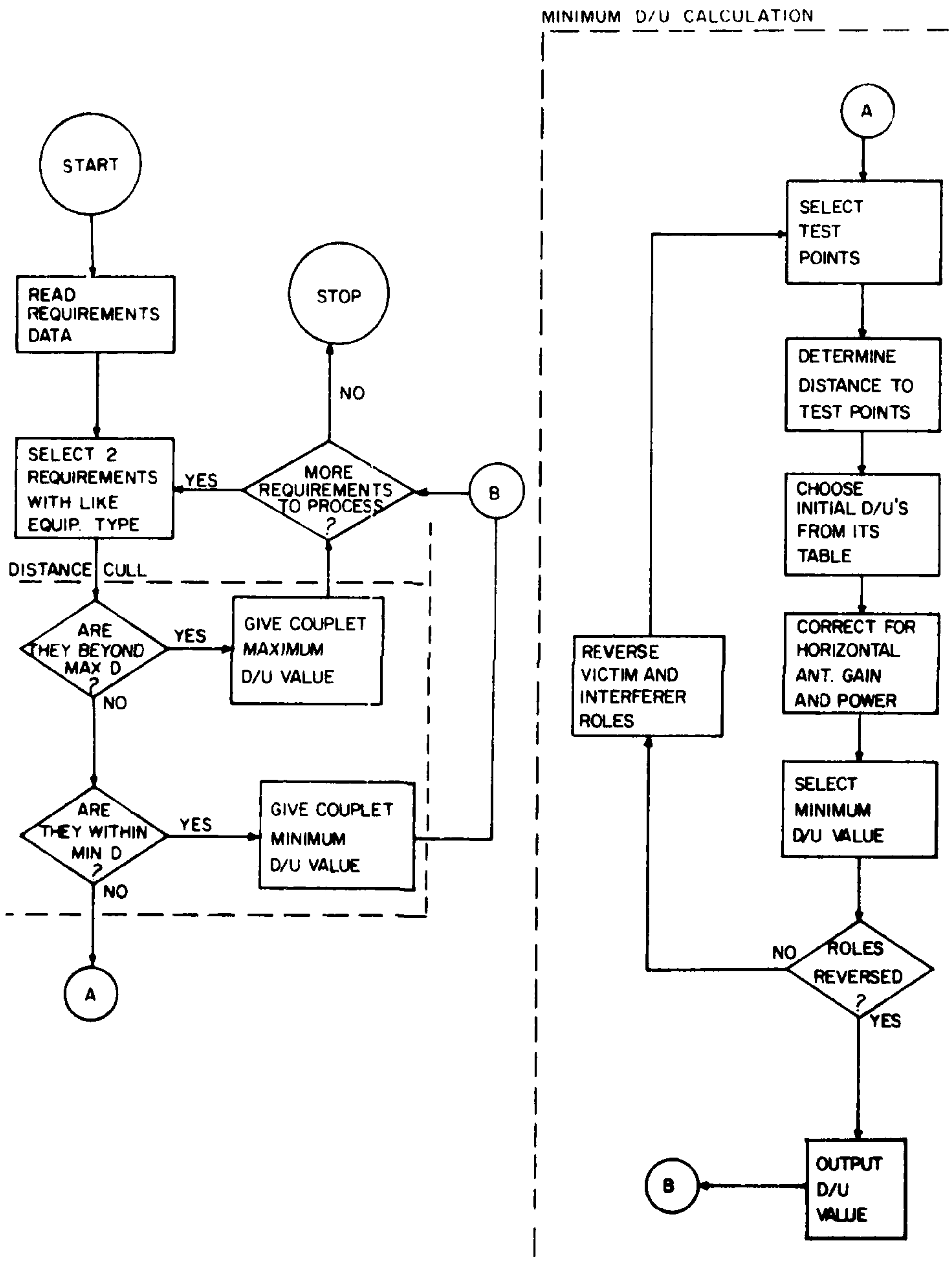

FIGURE 2. INTERSITE LOGIC FLOW.

two equipments (see FIGURE 3). An equipment pair separated by more than the cochannel distance boundary is assigned a cochannel D/U value. An equipment pair separated by less than the service volume distance boundary is assigned a worst-case D/U value, as defined by the protection criteria. The balance of the equipment pairs will require further analysis to determine the minimum D/U value, as shown in area B of FIGURE 3.

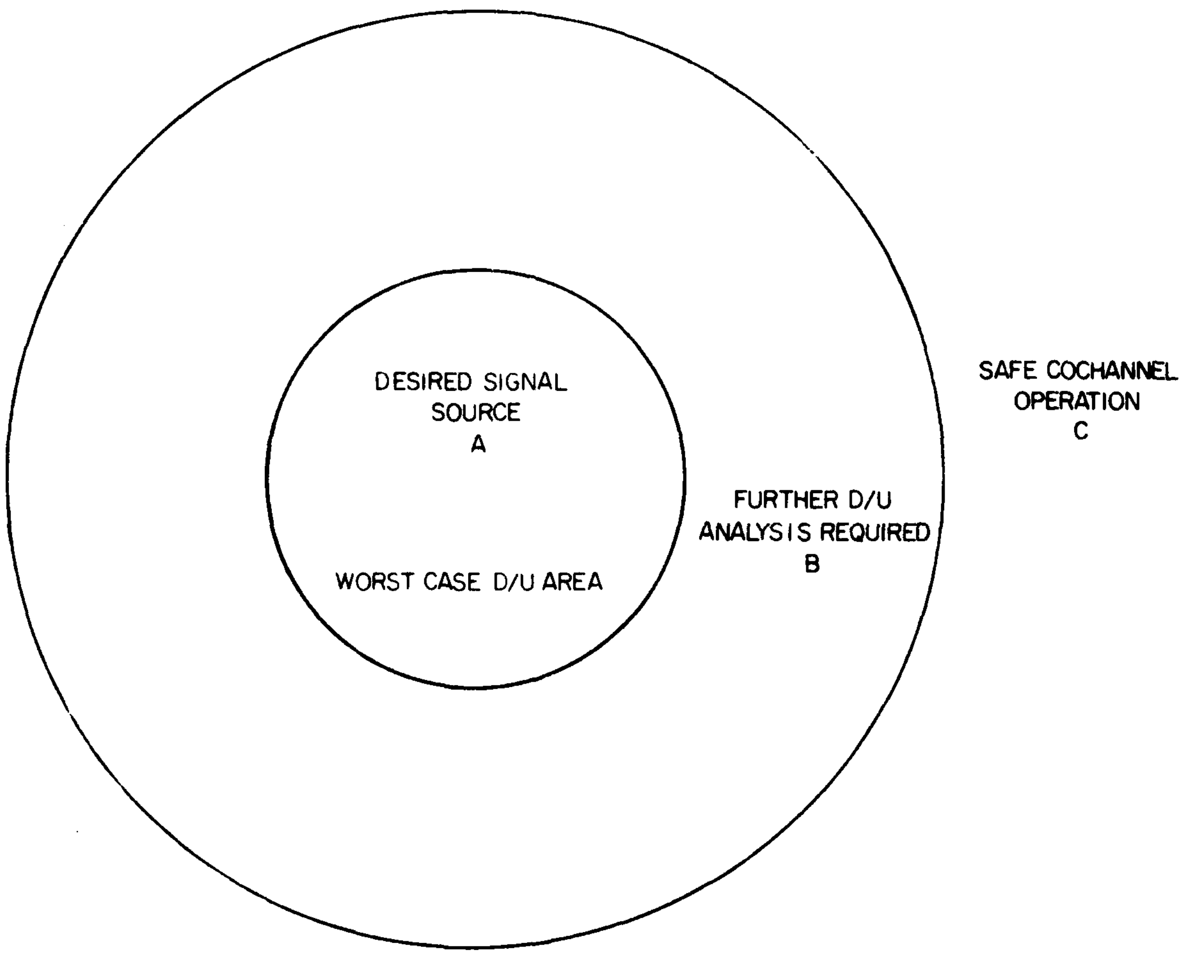

FIGURE 3. DISTANCE CULL BOUNDARIES

Minimum D/U Calculation

The minimum D/U is determined by calculating D/U ratios at critical test points (receiver locations) in the desired signal service volume and selecting the smallest value. The model is designed to analyze the circular service volumes associated with TACAN, VOR, conventional DME, and PDME equipments, as well as the various sector/circular service volumes associated with the ILS (Localizer and Glideslope) and MLS equipments. The location of the test points to be used was determined by an analysis described in APPENDIX A. In this analysis, it was shown that the minimum D/U value within the tailored service volumes associated with MLS and ILS equipment will occur at the maximum service volume range near one of three points. Those points, shown in FIGURE 4, are the corner points (B and D), and the intersection of the line connecting the desired and undesired equipments and the boundary of the desired equipments service volume, point (C).

The closest point may not have meaning when the non-circular tailored service volumes are used in the analysis. In a tailored service volume, if the undesired source is located within the angular limits of the desired service volume (case #1 in FIGURE 4), three points are selected, one at each corner of the service volume, and a third at the line connecting the desired and undesired source. When the undesired source is outside these angular limits, only the corner points are tested (case #2 in FIGURE 4). For circular service volumes, the angular limits are always considered to be $\pm$ 180°, making the undesired source always fall within the angular limits of the desired service volume. For that case, the model always uses the point on the line connecting the equipments, at the maximum service range.

The D/U calculation at each critical test point is performed by considering both the azimuth and elevation of the test point location with respect to the desired and undesired signal sources. A propagation model developed by ITS (Reference 4), which is based on a 95% time availability basis, has been integrated into this intersite analysis to calculate an initial D/U value for each test point based on the desired and undesired signal propagation losses and their vertical antenna gains in the direction of the victim receiver. These initial

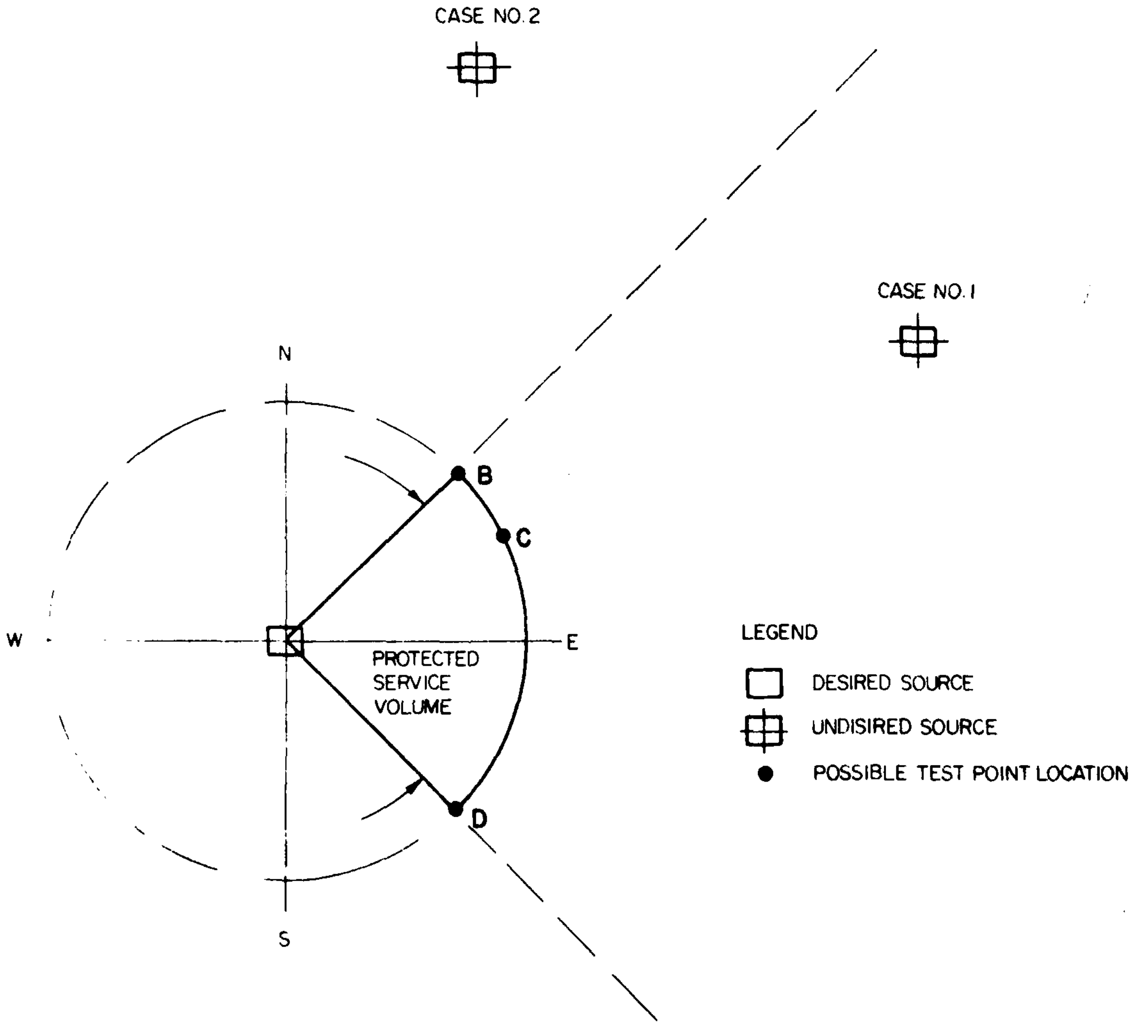

FIGURE 4. TEST POINT LOCATIONS IN A SECTOR SERVICE VOLUME.

D/U values are stored in a series of look-up tables prepared for each type of equipment. To obtain the final D/U values the initial D/U's are adjusted for transmitter power and horizontal antenna gain differences. The minimum D/U ratio is selected from this set of values.

The initial D/U ratio at each test point is determined by calculating the desired-to-undesired ground equipment separation distance[a], and interpolating from tabulated D/U curves prepared in advance. Every equipment service volume configuration (e.g., MLS, 20 nmi, and DME, 25 nmi, etc.) has a tabulated D/U curve to be used when that equipment undergoes analysis. FIGURE 5 shows the D/U curve prepared for an MLS 20 nmi service volume. Each curve has been constructed so that the D/U value at each site separation distance is the minimum that will occur at any altitude within the service volume limits.

The initial D/U values determined using the ITS curves are then adjusted by incorporating the difference between the desired and undesired signals, horizontal antenna gain in the direction of each test point, and the difference in transmitted power values between the desired and undesired signal sources, with the initial tabular D/U value.

The final D/U values calculated at the critical test points within the service volume of the desired source are then compared and the minimum D/U is stored. At this point, the model reverses the roles of the two equipments for the couplet being analyzed. The desired signal becomes the undesired signal and vice versa. The analysis is repeated using the same procedure described above, to calculate a second minimum D/U value. This second value is compared to the first value and the final minimum D/U is stored for use in the channel-assignment routine. The result is the smallest D/U value in the service volume of either equipment and its use assures the protection of both equipments.

The intersite analysis is performed for each individual equipment in an environment, with every other equipment in the same frequency band. At an

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[a]Equipment separation distance is the combination of the desired equipment-to-test point plus undesired equipment-to-test point distances.

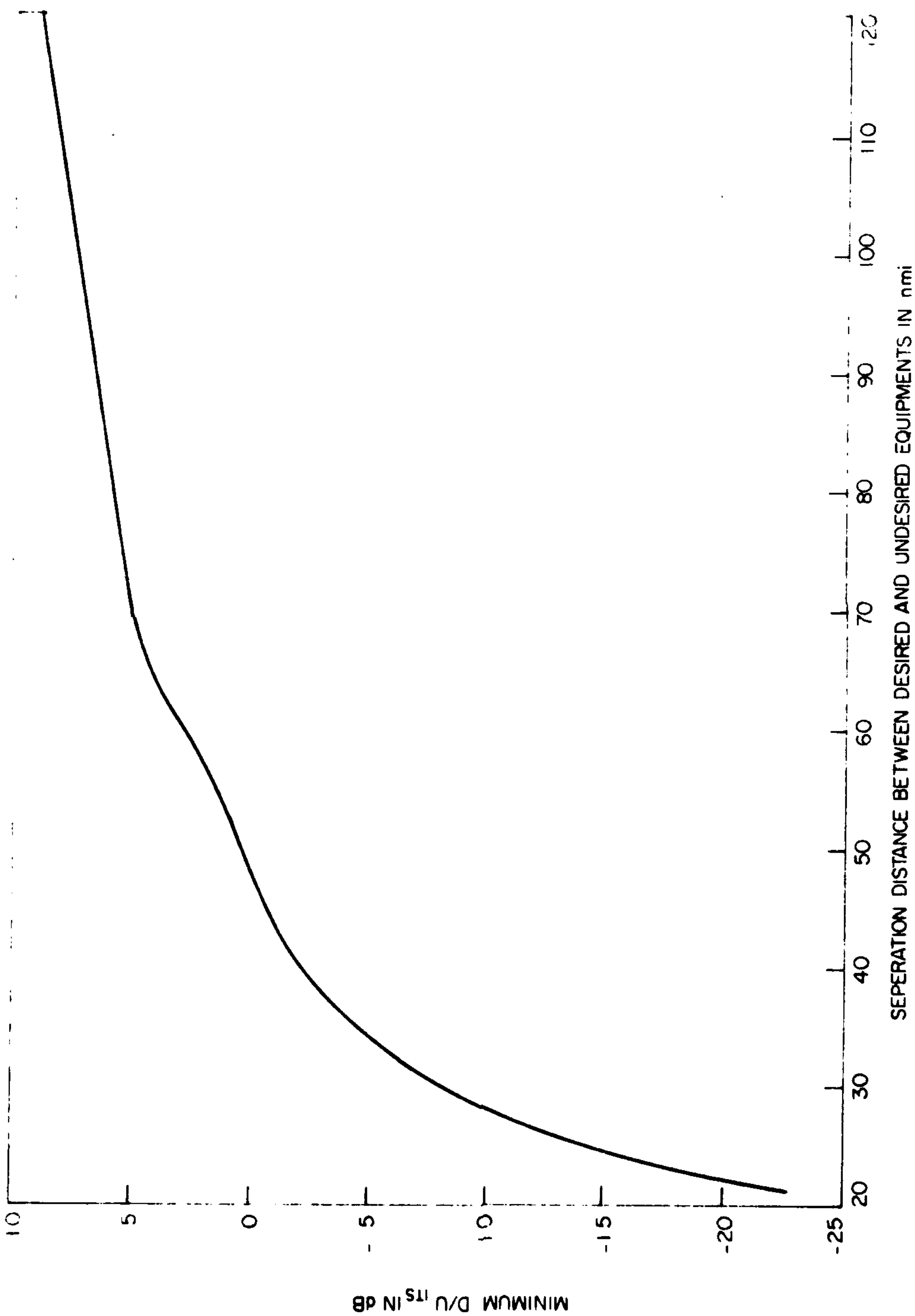


FIGURE 5. COMPOSITE D/U_{ITS} CURVES FOR 5,000, 10,000 and 20,000 FEET ALTITUDE.

airport facility where several different equipments are operating and providing various services, there will be a set of minimum D/U values, one associated with each of the equipments.

CHANNEL ASSIGNMENT

The channel-assignment model examines the intersite constraints existing between the equipments in a working environment, and assigns channels providing the channel separation required by the protection criteria. The user specifies the inputs to the routine: 1) the channelization scheme; 2) the protection criteria; 3) the data base defining the equipment operational parameters; and 4) the method of determining the priority of equipment assignments.

In addition to specifying the above inputs the user may also select preprogrammed options: 1) alternate channel pairing schemes; 2) reassignment of existing equipment assignments to other channels, and; 3) a display of the percentage of channels denied to equipments that fail to be assigned. A description of the model options and capabilities is included in section 3.

The assignment routine will be discussed in two parts, the denied channel array construction, and the final assignment process. The program flow is illustrated in FIGURE 6.

Denied Channel Array

The denied channel array is constructed prior to the beginning of the assignment process. It shows the frequencies that are available to each system[a] of equipments and does not initially reflect any of the intersite constraints between systems. This array is constructed in two steps: 1) listing the frequency resources available to each equipment type; and 2) entering a frequency resource list for each equipment into an array, according to the hard-pairing between equipments.

[a] A system is a set of equipments providing landing guidance at a runway site, or navigational guidance at an enroute facility. Each equipment in the environment to be assigned is identified with a system.

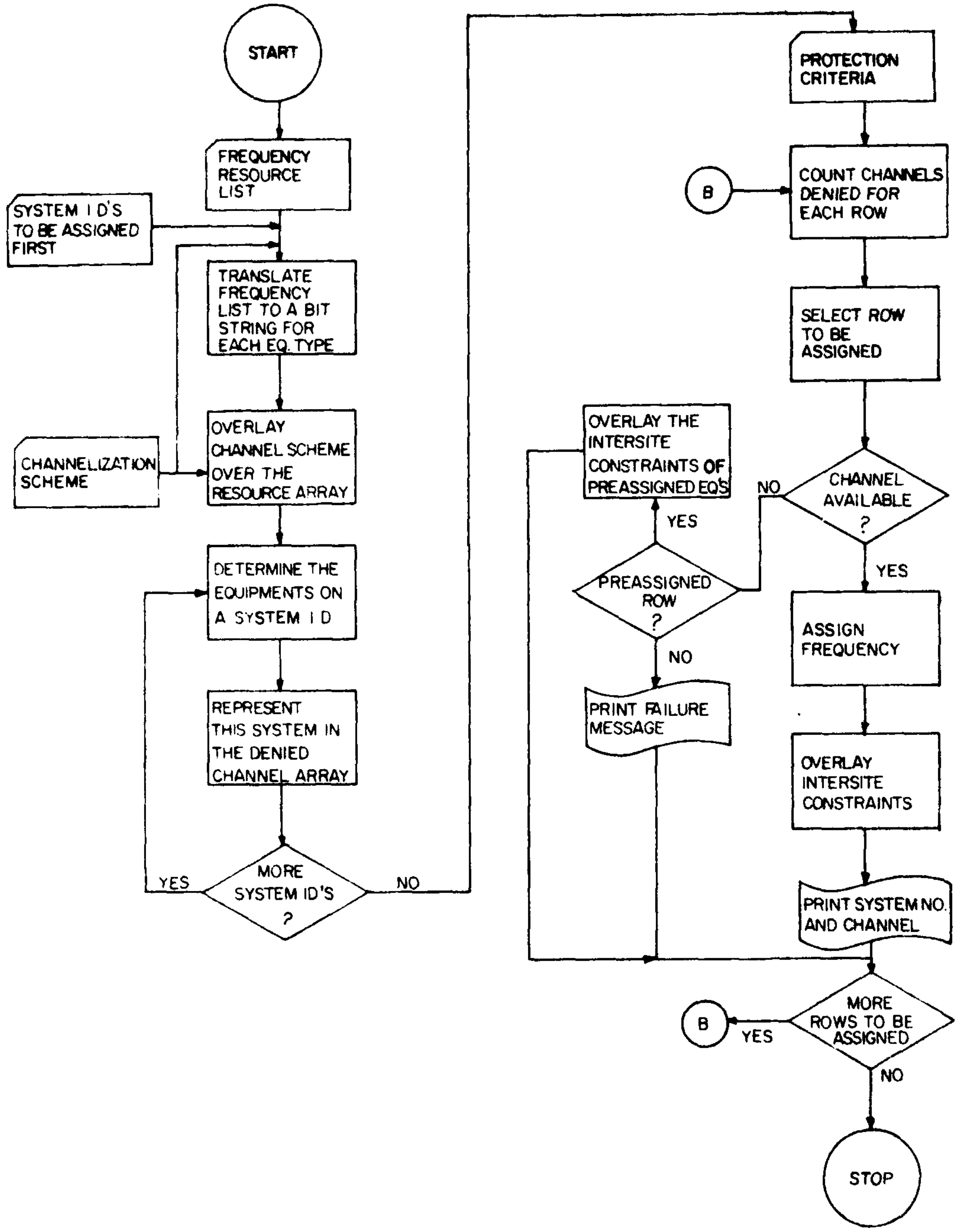


FIGURE 6. ASSIGNMENT ROUTINE LOGIC FLOW.

The first step is the creation of a frequency resource list for each equipment type to be considered in the assignment process. The channelization scheme defining the frequency resources available to each type of equipment is converted to a bit string, with "0's" indicating the available frequencies and "1's" indicating the denied frequencies. Step 1 of FIGURE 7 illustrates a frequency resource list constructed from the partial channel scheme listed.

The second step is to construct a denied channel array with columns representing frequency resources and rows representing the equipments to be assigned. Frequency resource lists for all equipments in a system are entered into the array according to equipment type and the required hard-pairing between equipments within each system. The model identifies the hard-paired equipments within a system and overlays their resource lists. Any frequency resource that is denied for one of the equipments results in the elimination of the corresponding resources on that channel for the entire hard-paired set. The result is an array showing the frequency resources available to each system of equipments.

Step 2 of FIGURE 7 illustrates the denied channel array row representing a hard-paired system of equipments composed of MLS, DME, ILS, and Glideslope. Four channels are available to their system: 18X, 18Y, 20X, and 20Y. In the event that no hard-pairing between equipments is desired, the denied channel array of FIGURE 7 would contain the four individual resource lists corresponding to the equipments that are listed, and no overlaying of these lists would occur.

When a system is preassigned (i.e., it is an existing system in the environment operating on a specific frequency), all channels except the preassigned one are denied to it. For example, if the system of FIGURE 7 were preassigned on channel 18X, all other channels would contain "1's" in the denied channel array shown. The user also has the optional capability to ignore the preassigned channel so that the system will be allowed assignment on any channel. Conversely, any system can be proposed for assignment on a specific channel by specifying for it a preassigned channel when the array is constructed.

Channel	MLS Angle	PDME	DME	VOR	ILS	Glideslope
17X			978	108.00		
17Y	5031.0	1,104	1,104	108.05		
17XZ	5031.3	978				
18X	5031.6	979	979		108.10	334.70
18Y	5031.9	1,105	1,105		108.15	334.55
18XZ	5032.2	979				
19X			980	108.20		
19Y	5032.5	1,106	1,106	108.25		
19XZ	5032.8	980				
20X	5033.1	981	981		108.30	334.10
20Y	5033.4	1,107	1,107		108.35	333.95
20XZ	5033.7	981				

Step 1 Frequency Resource List

	17	18	19	20
	X Y XZ	X Y XZ	X Y XZ	X Y XZ
MLS Angle	1 0 0	0 0 0	1 0 0	0 0 0
PDME	1 0 0	0 0 0	1 0 0	0 0 0
DME	0 0 1	0 0 1	0 0 1	0 0 1
VOR	0 0 1	1 1 1	0 0 1	1 1 1
ILS	1 1 1	0 0 1	1 1 1	0 0 1
Glideslope	1 1 1	0 0 1	1 1 1	0 0 1

Step 2 Denied Channel Array

	17	18	19	20
	X Y XZ	X Y XZ	X Y XZ	X Y XZ
MLS Angle, DME, ILS, Glideslope	1 1 1	0 0 1	1 1 1	0 0 1

0 - channel available

1 - channel not available

FIGURE 7. DENIED CHANNEL ARRAY CONSTRUCTION.

Assignment

The assignment model uses the denied channel array to systematically assign each system in the environment to an available channel. After each successful assignment, the denied channel array is updated to reflect the intersite constraints between the most recently assigned system and all the remaining unassigned systems. The minimum D/U values between each system, calculated in the intersite analysis, have been translated into the channel separation required for safe operation as defined by the protection criteria listed in APPENDIX C. These channel separations determine the channel spacing required between systems when updating the denied channel array.

In normal operation, the model begins assigning systems by counting the frequency resources denied to each system (row) and first assigning those systems with the fewest remaining resources. As an option, the model may select the first system to be assigned from a list specified by the user. The row representing this first system to be assigned is searched for an available channel, and the first free channel is assigned[a]. If no channel is available, the model prints a failure message and proceeds to the next assignment.

When an assignment is made, intersite constraints may be placed on some of the remaining unassigned systems. If necessary, the channel assigned, and some number of adjacent channels will be eliminated from the rows of potentially interfering systems. This process updates the denied channel array for the next assignment attempt.

FIGURE 8 illustrates the channel assignment process for three systems, beginning with the denied channel array. System one is assigned its first available channel, and the denied channel array is updated to reflect the channel separation required between the systems, as a result of this assignment. The process continues in the same manner, until assignment has been attempted for all systems.

---

[a]The sequence of channels as listed by the user represents an optional capability.

Begin - Denied Channel Array					
	17	18	19	20	
System	X Y XZ	X Y XZ	X Y XZ	X Y XZ	Protection Required
1. MLS Angle DME ILS Glideslope	1 1 1	0 0 1	1 1 1	0 0 1	1↔2 1 Channel 1↔3 1 channel 2↔3 2 channel
2. MLS Angle DME ILS	1 1 1	0 0 1	1 1 1	0 0 1	Assign System 1 Channel 18 X
3. MLS Angle PDME	1 0 0	0 0 0	1 0 0	0 0 0	

1ST - Updated Channel Array					
	17	18	19	20	
System	X Y XZ	X Y XZ	X Y XZ	X Y XZ	
2	1 1 1	1 0 1	1 1 1	0 0 1	Assign System 2 Channel 18 Y
3	1 0 0	1 0 0	1 0 0	0 0 0	

2ND - Updated Channel Array					
	17	18	19	20	
System	X Y XZ	X Y XZ	X Y XZ	X Y XZ	
3	1 0 0	1 1 1	1 0 0	0 0 0	7 Available Channels for Assignment

FIGURE 8. CHANNEL-ASSIGNMENT PROCESS.

It should be noted that for clarity purposes in this example, channels 17X, 17Y and 17XZ have been treated simplistically as adjacent channels. However, in reality this is dependent upon the channel plan definition. An examination of the channel plan defined in APPENDIX E reveals that the C-band frequencies contained in channels 17X, 17Y and 17XZ are adjacent frequencies, but that the L-band frequencies are not. L-band channels 17X and 18X contain adjacent frequencies. Therefore, when the denied channel array is updated by the channel assignment system to reflect the impact of a particular assignment on adjacent channels, each band is updated separately, and the results are combined (logical OR) to decide if a particular channel (paired set of frequencies) is available for future use.

Additional note should be made of the effect of using the APPENDIX E channel plan. Adjacent channel restrictions would usually affect separate L- and C-band channels, thus in some cases denying twice as many channel numbers as may be required for a more optimally defined plan.

A special situation arises when assigning systems containing preassigned equipments. In the assignment process, an existing preassigned system, hard-paired with a new MLS equipment, may be unable to use its existing "preassigned" channel because of intersite constraints placed on the MLS from prior assignments. In this case, a reassignment option is available to the user, and allows the assignment routine to search for any available channel to assign the entire system; planned plus existing. If this option fails, the hard-pairing requirement may be relaxed at the discretion of the user, thus allowing the planned MLS portion to be assigned separately from the existing equipment.

DATA BASE

The MLS data base consists of an individual data record for each equipment in the environment. Each equipment (subsystem) record contains a system identification number which links it with other equipments that form a system at the same facility in the environment. A system is a set of equipments providing landing guidance at an airport, or navigational guidance at an enroute guidance site. An airport facility may contain many systems, associated with various runways.

A data record contains information for both the equipment, and the airport/enroute facility where its associated system is located. The equipment information includes the type and location, as well as the service and operational parameters. The facility information includes the identification, location, and service capability of the airport or enroute site.

A user wishing to create a new environment for use in the channel assignment model must provide the information needed to construct a data record for each individual equipment in that environment. Certain of the information contained on the data record is not crucial to the actual operation of the assignment model. The information that is necessary for the model operation and must be supplied, is identified by an asterisk in the description that follows. The information contained on each equipment record is as follows:

Equipment Data[a]

1. Equipment Type* - Identifies the type of equipment contained on the record (e.g., TACAN, VOR, etc.).
2. Equipment Lat./Long.* (degrees, minutes, seconds) - Latitutde and longitude of the equipment location.
3. Channel* - The designated channel of a preassigned L-band or VHF equipment.

[a]APPENDIX B defines equipment parameters and service options for each equipment type.

4. Frequency (MHz)* - The operating frequency of a preassigned L-band or VHF equipment.

5. Service Radius* (nmi) - The radius of the protected service volume.

6. Altitude (ft.)* - The maximum protected altitude within the service volume.

7. Service Volume* - Type of L-band or C-band service volume coverage (e.g., High, Low, Terminal, MLS Service Volume). This parameter should be specified when the service volume is of a standard type. The standard service volumes in use are listed in APPENDIX B.

8. Option* - Type of ILS service coverage. (Standard, Option 1, Option 2, Option 3). This parameter should be specified when a standard option, listed in APPENDIX B, is chosen.

9. Gain (dBi)* - Mainbeam antenna gain.

10. Power (kW)* - Effective power input to the antenna.

11. Antenna Pattern* - Type of vertical antenna pattern.

12. Height (ft.)* - Transmitter antenna height.

Facility Data

1. Airport/Enroute Facility Number* - This is the system identification number; it identifies the system, or group of equipments, providing guidance to a specific runway or enroute navigation site (i.e., all equipments associated with a runway/enroute site have the same facility number). Each equipment data record must have a facility number to insure that the equipments to be channel-paired at each site can be identified.

2. Location* - The city and state of an airport facility, or the state and location of an enroute site.

3. Airport Lat./Long. (degrees, minutes, seconds) - The latitude and longitude of airports (no entry for enroute facilities).

4. Bearing of Runway (degrees)* - The bearing of a runway associated with an airport facility.

5. Facility Call Number - Three alphanumeric characters identifying an airport facility or enroute site.

6. Airport Type - Categories designating the status and type of service for an airport facility.

New - not in existence

General Aviation - general air traffic

Air Carrier - all commercial aviation

V/STOL - special takeoff and landing facility

7. Tower Exist - Indicates whether a tower exists.

8. Runway Exist - Indicates whether a runway is in existence.

9. Frazier's Number - The number assigned to a system in the proposed environment developed in 1972.

10. Link Number* - A link number identifies those equipments which must operate on the same frequency. This situation arises when two like equipments are located at opposite ends of a runway, or on adjacent parallel runways, but do not operate simultaneously. By linking equipments, all guidance for a runway will be on the same frequency.

11. Runway length (ft.)

12. Runway Width (ft.)

SECTION 3

USER OPTIONS AND MODEL CAPABILITIES

GENERAL

The MLS Channel Assignment Model was constructed principally as a tool for evaluating the various channelization schemes proposed for the MLS angle guidance and range guidance equipments. In order for the model to handle a variety of channel plans, perhaps requiring special environmental assignment considerations, it was necessary to provide certain options that give the user sufficient flexibility to test particular ideas. User options are accomplished in two ways: (1) through the main inputs to the model and (2) by selecting internal system options that regulate the assignment process. By utilizing these options, the user may investigate assignment ideas in different airport environments, using various MLS characteristics and with specialized protection criteria. This section will describe these options and some example problems that can be investigated using this assignment model. The current use of this channel assignment model at ECAC is accomplished through the FAA Spectrum Support Office.

USER OPTIONS

The following is a description of the input options and model options available to the user.

Input Options

The main input options under user control are the equipment protection criteria, the channel plan, the data base including the environment description, and the assignment priority list. By controlling these key inputs, many options are available to the user.

Protection Criteria. The protection criteria places upper bounds on the undesired signal level (U) with respect to the desired signal level (D) that provide for interference-free operation of the potential victim equipment within standard protected service volumes. Levels are specified as a D/U power ratio for cochannel and adjacent channel undesired signals. Different criteria are used in each frequency band as described in detail in APPENDIX C. The user has the option of specifying established protection criteria or updated criteria based on analytical or emphirical results as equipment designs change.

The L-band protection criteria included in TABLE C-1 are consistent with current FAA frequency assignment methods found in the U.S. National Standard for the VORTAC System for X-mode channels. However, the planned use of multiple-modes for the MLS range guidance system and the planned revision of the national standard to consider the source/type of the undesired signal, have spawned the need for a more detailed specification of L-band protection criteria. In particular, the L-band protection matrix shown in TABLE 1 satisfies the structure needed to specify the required criteria. This matrix treats each combination of victim equipment and potentially interfering equipment on an individual basis, allowing the interference rejection advantage of the newer PDME equipments to be reflected in the assignment process. The user simply needs to provide the applicable inputs. As the MLS range guidance system matures or as older conventional TACAN/DME systems are deleted from the operational inventory, these criteria can be updated at the option of the user.

The C-band protection criteria included in TABLE C-2 were based on analytical work by ECAC and the Bendix Corporation, and substantiated by emphirical testing at NAFEC. As with range guidance protection, these criteria are under user control and may be updated as the system matures.

The VHF and UHF protection criteria are contained in TABLES C-3 and C-4 respectively for the VOR, ILS Localizer and ILS Glideslope systems which are channel-paired to selected L-band frequencies as outlined in Section 1. The thresholds are planned for incorporation by the FAA into the revised national standard. Again, as with L- and C-bands, these criteria are under user control and can be updated as required.

TABLE 1

SAMPLE L-BAND PROTECTION MATRIX IN dB

Undesired Source / Desired Source	TACAN			DME (100W)			PDME		
	TACAN	DME	PDME[b]	TACAN	DME	PDME[b]	TACAN	DME	PDME[b]
Cofrequency, Co-aperture	+8	+8	+8	+8	+8	+8	+8	+8	+8
Cofrequency Out-of-aperture	—	—	-50	—	—	-50	+8	+3	-50
First adjacent frequency, Co-aperture	-42	-46	-60	-29[a]	-29[a]	-60	-75	-25	-60
First adjacent frequency, Out-of-aperture	—	—	-75	—	—	-75	-34	-34	-75
Second adjacent frequency, Co-aperture	-50	-54	-75	-38	-38	-75	-34	-34	-75
Second adjacent frequency, Out-of-aperture	—	—	-75	—	—	-75	-34	-34	-75

[a] For an undesired IKW DME, these D/U become -39dB

[b] If PDME systems are assigned on conventional X or Y channels, the required protection criteria is the same as for conventional TACAN/DME equipment.

Channel Plan. The channelization scheme defines the frequencies that are available in each frequency band and identifies each set by a channel number. The MLS Channel Assignment System is capable of accepting channel plans with paired frequencies from four different bands for each channel number. A proposed channel plan is listed in APPENDIX E. Note that the L-band frequencies are in two sets, those available for conventional TACAN/DME equipment and those available for PDME equipment.

A channel plan may contain any number of channels with any subset of frequencies from the C-, L-, VHF-, and UHF-bands defined for each channel. The assignment model will accept any number of modes (pulse-pair spacings) within the L-band portion of the channel plan, and the channels may be listed in any order desired. TABLE 2 shows a sample channel plan containing 10 channels, each with paired frequencies from more than one band. Note some options available to the user in defining channels in the sample plan. Channel 18X contains frequencies from all four bands and allows MLS angle and range guidance, conventional TACAN/DME, and a complete ILS system to operate on that channel. However, channel 18B is an exclusive MLS channel for angle and range guidance only, and channel 19X is not available for MLS use but only for enroute VOR-DME facilities.

TABLE 3 shows this same plan with the channels listed in a different order. This ordering option gives the user the choice of defining a particular channel implementation sequence or "packing order". This determines the order in which the assignment model will search for an available channel during the dynamic assignment process. For a channel plan as listed in TABLE 3, the assignment model will search for an available channel starting with 18X for each assignment attempt and continue searching through 19X, 18Y, 19Y, etc., until an available channel is found or until the channel resources are exhausted. In this manner, successful facility channel assignments are "packed" on the left-most channels, thus saving those on the right for later implementation.

Data Base. The MLS Data Base contains the equipment operational parameter and facility information required by the assignment model when performing an assign-

TABLE 2

EXAMPLE CHANNEL PLAN

1	18X	18Y	18A	18B	18C	19X	19Y	19A	19B	19C
MLS	5031.60	5031.9	5032.2	5032.5	5032.8	--	5033.1	5033.4	5033.7	5034.0
PDME	979.0	1105.0	979.0	979.0	979.0	--	1106.0	980.0	980.0	980.0
TACAN/DME	979.0	1105.0	--	--	--	980.0	1106.0	--	--	--
ILS/VOR	108.1	108.15	--	--	--	108.2	108.2	--	--	--
Glideslope	334.7	334.55	--	--	--	--	--	--	--	--

TABLE 3

ALTERNATE PACKING ORDER

	18X	19X	18Y	19Y	18A	19A	18B	19B	18C	19C
MLS	5031.6	--	5031.9	5033.1	5032.2	5033.4	5032.5	5033.7	5032.8	5034.0
PDME	979.0	--	1105.0	1106.0	979.0	980.0	979.0	980.0	979.0	980.0
TACAN/DME	979.0	980.0	1105.0	1106.0	--	--	--	--	--	--
ILS/VOR	108.1	108.2	108.15	108.25	--	--	--	--	--	--
Glidescope	334.7	--	334.55	--	--	--	--	--	--	--

ment. Section 2 contains a listing of the information contained in the data base. This information is initially entered on data cards after which it is processed and organized onto record files containing all the required equipment data at a specific runway. FIGURE 9 shows the resulting compiled records for four ways in the Northeast United States.

Currently, there are three environments contained on MLS data base records. The first is a Soutwest United States environment containing the existing and planned airport and enroute equipments in a four-state soutwest region, including the Los Angeles basin. This environment was based on a predicted 1980 airport environment which included proposed new facilities as they were envisioned in 1972. A listing of this environment is contained in APPENDIX D. The second environment is a modification of the first made by deleting many of the proposed runways which were not built by 1980. The third environment consists of 20 states in the Northeast, East Central and Southeast United States region. All of these environments include high density airport regions that present conservative conditions from a channel assignment standpoint.

The MLS data base structure was intended to provide flexibility to the assignment model in that the key information needed for an assignment is contained in the data base record, which can be easily changed to suit a user's wishes. Equipment records can easily be added to or deleted from the data base through preprogrammed maintenance routines. In addition, records can be altered on an individual or environment-wide scale. This gives the user the capability of altering, for instance, the service volume coverage, transmitted power, antenna gain and radiation patterns of individual equipment records, or a specific type of equipment throughout the entire environment.

Equipment Assignment Priority. The normal operation of the channel assignment model uses a dynamic ordering technique to determine the order in which equipment will be assigned channels.

FACILITY NUMBER	LOCATION STATE/CITY	FACILITY LATITUDE	FACILITY LONGITUDE	BEAR	FAC CALL	AIRPORT TYPE	TOWER EXIST	RUNWAY EXIST	FRAZIER NUMBER	LINK	RUNWAY LENGTH	RUNWAY WIDTH	AGENCY
1	CT/BRIDGEPORT	41 09 49 N	073 07 35 W	110	BDR	EXS AIR CARR	NO	YES	0	1	4677	150	FAA

EQUIPMENT	LATITUDE	LONGITUDE	CHANNEL	FREQ	RAD	ALT	SERVICE	OPT	GAIN	POWER	PAT	HGT	(+)HOR	(-)HOR	(+)VER	(-)VER
SMALL COMNTY	41 09 55 N	073 07 12 W	0	.000	20	20000	MLS		23.0	1.8	SM.CM.	10	40	40	20.0	1.0
ILS-DME	41 09 30 N	073 07 44 W	44X	1005.000	25	12000	TERMIN		11.4	100.0	CARDIO	35	180	180	.0	.0
P-DME	41 09 30 N	073 07 44 W	0	.000	20	20000	TERMIN		8.5	50.0	PDME	35	180	180	.0	.0
ILS 1	41 09 55 N	073 07 12 W	44X	110.700	10	4500		1	12.0	100.0	WILCOX	9	35	35	7.0	2.0
GLIDESLOPE-1	41 09 55 N	073 07 12 W	44X	330.200	10	1000		1	5.0	5.4	NULL	[illegible]	8	8	2.0	4.0

FACILITY NUMBER	LOCATION STATE/CITY	FACILITY LATITUDE	FACILITY LONGITUDE	BEAR	FAC CALL	AIRPORT TYPE	TOWER EXIST	RUNWAY EXIST	FRAZIER NUMBER	LINK	RUNWAY LENGTH	RUNWAY WIDTH	AGENCY
2	CT/BRIDGEPORT	41 09 49 N	073 07 35 W	290	BDR	EXS AIR CARR	NO	YES	0	1	4677	150	FAA

EQUIPMENT	LATITUDE	LONGITUDE	CHANNEL	FREQ	RAD	ALT	SERVICE	OPT	GAIN	POWER	PAT	HGT	(+)HOR	(-)HOR	(+)VER	(-)VER
SMALL COMNTY	41 09 49 N	073 07 35 W	0	.000	20	20000	MLS		23.0	1.8	SM.CM.	10	40	40	20.0	1.0
MARKER BECON	41 09 49 N	073 07 35 W	0	75.000	25	12000	TERMIN		11.4	100.0	CARDIO	35	180	180	.0	.0
P-DME	41 09 49 N	073 07 35 W	0	.000	20	20000	TERMIN		8.5	50.0	PDME	35	180	180	.0	.0
*VOR 2-4	41 09 49 N	073 07 35 W	0	.000	25	12000	TERMIN		2.2	50.0	COSINE	12	180	180	.0	.0
*ILS 2	41 09 49 N	073 07 35 W	0	.000	17	6250		2	12.0	100.0	WILCOX	8	35	35	7.0	2.0
*GLIDESLOPE-2	41 09 49 N	073 07 35 W	0	.000	10	1000		2	5.0	5.4	NULL	[illegible]	8	8	2.0	4.0

FACILITY NUMBER	LOCATION STATE/CITY	FACILITY LATITUDE	FACILITY LONGITUDE	BEAR	FAC CALL	AIRPORT TYPE	TOWER EXIST	RUNWAY EXIST	FRAZIER NUMBER	LINK	RUNWAY LENGTH	RUNWAY WIDTH	AGENCY
3	CT/DANBURY	41 22 18 N	073 28 56 W	80	DXR	EXS GENERAL	YES	YES	0	0	4419	150	FAA

EQUIPMENT	LATITUDE	LONGITUDE	CHANNEL	FREQ	RAD	ALT	SERVICE	OPT	GAIN	POWER	PAT	HGT	(+)HOR	(-)HOR	(+)VER	(-)VER
SMALL COMNTY	41 22 18 N	073 28 56 W	0	.000	20	20000	MLS		23.0	1.8	SM.CM.	10	40	40	20.0	1.0
MARKER BECON	41 22 18 N	073 28 56 W	0	75.000	25	12000	TERMIN		11.4	100.0	CARDIO	35	180	180	.0	.0
P-DME	41 22 18 N	073 28 56 W	0	.000	20	20000	TERMIN		8.5	50.0	PDME	35	180	180	.0	.0
*VOR 2-4	41 22 18 N	073 28 56 W	0	.000	25	12000	TERMIN		2.2	50.0	COSINE	12	180	180	.0	.0
*ILS 2	41 22 18 N	073 28 56 W	0	.000	17	6250		2	12.0	100.0	WILCOX	9	35	35	7.0	2.0
*GLIDESLOPE-2	41 22 18 N	073 28 56 W	0	.000	10	1000		2	5.0	5.4	NULL	[illegible]	8	8	2.0	4.0

FACILITY NUMBER	LOCATION STATE/CITY	FACILITY LATITUDE	FACILITY LONGITUDE	BEAR	FAC CALL	AIRPORT TYPE	TOWER EXIST	RUNWAY EXIST	FRAZIER NUMBER	LINK	RUNWAY LENGTH	RUNWAY WIDTH	AGENCY
4	CT/GROTON	41 19 47 N	072 02 49 W	50	GON	EXS GENERAL	NO	YES	0	0	5000	150	FAA

EQUIPMENT	LATITUDE	LONGITUDE	CHANNEL	FREQ	RAD	ALT	SERVICE	OPT	GAIN	POWER	PAT	HGT	(+)HOR	(-)HOR	(+)VER	(-)VER
SMALL COMNTY	41 20 16 N	072 02 14 W	0	.000	20	20000	MLS		23.0	1.8	SM.CM.	10	40	40	20.0	1.0
ILS-DME	41 20 16 N	072 02 14 W	50X	1011.000	25	12000	TERMIN		11.4	100.0	CARDIO	35	180	180	.0	.0
P-DME	41 20 16 N	072 02 14 W	0	.000	20	20000	TERMIN		8.5	50.0	PDME	35	180	180	.0	.0
ILS 1	41 20 16 N	072 02 14 W	50X	111.300	17	6250		2	12.0	100.0	WILCOX	8	35	35	7.0	2.0
GLIDESLOPE-1	41 20 16 N	072 02 14 W	50X	332.300	10	1000		2	5.0	5.4	NULL	[illegible]	8	8	2.0	4.0

FIGURE 9. DATA BASE RECORDS

This technique determines the equipment with the minimum number of available channels remaining in its list of channel resources, and attempts to assign that equipment next.

As an option, the assignment model is capable of accepting an assignment priority list specifying the order in which equipments will be assigned. Furthermore, the user may input an assignment order for only some of the equipments to be assigned; when this list is exhausted, the model will revert back to the dynamic technique for the remaining assignments.

The advantage of inputing a specific assignment order is that the user can simulate the actual order that equipment may be implemented. He may wish to place highest priority on the large metropolitan airports that require the newest equipment to meet their needs, and lower priority on the smaller, less congested facilities.

Model Options

The main model options under user control are frequency pairing options, reassignment options involving preassigned ILS and DME equipment, and the option to display certain diagnostic information regarding the most likely cause of an assignment failure at a particular facility.

Pairing Options. The MLS channel assignment model has the capability of "hard pairing" equipment assignments in different frequency bands. Hard pairing requires that the guidance equipment associated with a specific runway must all operate on the same channel even though they may be in different frequency bands. This requirement makes channel selection at runway interdependent between the various equipments; if one equipment cannot be assigned on a given channel, the remaining paired equipments cannot be assigned. The following degrees of pairing are available as an option to the user:

1. total pairing of all the equipments at a runway site, i.e., hard pairing of equipments in all four bands.

2. no pairing between frequency bands, allowing all equipments to be assigned independently of equipments in other bands.

3. pairing of various combinations of equipments, for instance pairing of MLS C-band equipments with PDME at a runway site. Any combination of equipments can be paired in this manner.

Reassignment Option. Any existing or proposed airport environment developed to exercise the channel assignment model will contain a significant number of existing equipments (i.e., ILS) operating on preassigned channels. In the assignment process, these equipments are automatically assigned to their present operating channel. However, if new MLS or PDME equipments are hard paired to the existing equipment at the same runway, the existing preassigned channel may not provide the necessary interference protection for the new equipment in a congested environment. When this occurs, the entire hard-paired set of equipments will fail, including the existing preassigned equipment. The model declares that channel (i.e., hard-paired set of frequencies) to be not available at that site. The channel assignment system then provides two options to the user:

1. When a preassigned set of equipments fails to retain its existing channel, the entire set may be reassigned to any open channel, providing that channel contains a sufficient set of frequencies, or

2. Carrying the above option one step further, if the entire set of equipments at a particular runway cannot be placed on an open channel, the paired set of equipments can be broken and the proposed MLS and PDME equipments may be assigned to any open channel while the preassigned ILS Localizer and Glideslope will be placed each on their original channel.

Display the Most Constrained Equipment. When a paired set of equipments at a runway fails to be assigned a channel, it is desirable to know which equipment was most likely to have caused the failure. The channel assignment system has the capability of listing the percentage of the channels that are denied to each equipment in the paired set to show exactly which equipment was the most constrained at the time of failure. This capability is intended as a diagnostic aid in determining those aspects of a channelization scheme that may be unworkable or most constraining.

SECTION 4

RESULTS

A channel-assignment model was constructed that is capable of performing an intersite analysis between interfering equipments in a user-input environment and assigning channels based on user designated intersite protection requirements and channelization scheme. A trial assignment was made for the Southwest U.S. airport environment listed in APPENDIX D.

The results of the first MLS trial assignment are summarized in TABLE 4. APPENDIX D contains a listing of the specific channels assigned to each system in the environment.

TABLE 4

TRIAL ASSIGNMENT SUMMARY

MLS Requirements		Successful Assignments	
Preassigned[a]	103	60	(58%)
New Assignments	252	237	(94%)
Total	355	297	(84%)

[a]"Preassigned" refers to new MLS systems which are frequency-paired to existing ILS-DME systems at the same runway. Therefore, their frequencies are predetermined.

It should be noted that in attempting to assign a C-band frequency to a "preassigned" MLS requirement, if the assignment failed for the existing channel, no alternatives were attempted (i.e., existing assignments were not changed in this first trial assignment).

The following is a summary of the most significant qualifications that should be used to place this initial trial in the proper context:

1. It was assumed that the PDME interrogator receiver would operate in the "narrowband" mode outside a radius of 5 nmi. This assumption resulted in an optimistic L-band assignment. If, as currently planned, this receiver operates "wideband" all the time, a more stringent assignment criterion will need to be applied and a greater rate of assignment failure will result.

2. Only one test environment, the Southwest U.S., was used to exercise the assignment model. It is expected that upon exercising the Northeast U.S. environment, a higher rate of assignment failure will occur. This is anticipated due to the greater numbers (4X) of preassigned ILS facilities and a greater density of enroute TACAN and VOR facilities in that area.

3. The channel plan used to exercise this particular trial channel assignment contains rigid frequency-pairing requirements throughout the C, L, VHF, and UHF bands. Other channelization schemes may contain selective frequency-pairing options that could results in a higher rate of assignment success.

4. Consistent with traditional L-band channel assignment techniques, potential ground-to-ground interactions between Y-mode DME's and X/XZ mode DME's were not considered in this trial assignment.

5. The protection criteria necessary for wideband PDME transponder operations have not yet been determined nor applied in this model.

6. Refinements in the protection criteria being established by the revised (draft) VORTAC National Standard had not been incorporated into the model at the time of its initial exercise. These refinements could result in a greater rate of assignment failure for all types of L-band equipments with the exception of TACAN-to-TACAN interactions.

7. The present protection of the MLS angle-guidance 3° (small community) system is considered to be conservative. The protected service volume was extended from $\pm 10°$ to $\pm 40°$ in azimuth to afford protection for the fly-left/fly-right pulses. Refinement of this technique may result in a greater number of successful C-band assignments.

8. Experimentally determined C-band and L-band protection criteria will eventually replace the analytically determined values of APPENDIX C. This may alter the assignment results.

9. Propagation predictions for calculating D/U values were based on smooth-earth terrain. That is, terrain shielding effects were not considered. This represents a "worst case" propagation prediction.

10. The equipment operational parameters (power levels, antenna gains) and antenna patterns listed in the MLS data base were chosen to represent a conservative but realistic working environment. The actual working environment may contain a wider range of values than was exercised in this assignment.

APPENDIX A

ANALYSIS APPROACH FOR DETERMINING MINIMUM D/U VALUES

The *MLS intersite analysis* examines the interference potential between two equipments and determines the minimum, i.e., worst-case, desired-to-undesired signal power ratio, D/U, within the service volume of either equipment. Because of the tailored service volumes and directional antennas associated with MLS and ILS equipments, a more rigorous analysis technique is required to find the minimum D/U than has been developed for circular service volumes. The approach used is to calculate the D/U at predetermined test points/locations within the service volumes, and then choose the smallest value. The accuracy of this method depends on choosing the correst test points for consideration.

The following equation was used to calculate the desired-to-undesired signal power ratio (D/U) at a victim receiver:

$$D/U = [G_D - VG_D - HG_D + EIRP_D - PL_D] - [G_U - VG_U - HG_U + EIRP_U - PL_U] \quad (A\text{-}1)$$

where

D/U = desired-to-undesired power ratio, in dB

G = mainbeam antenna gain of the desired (D) or undesired (U) equipments, in dBi

VG, HG = the normalized vertical and horizontal antenna gains (desired or undesired) in the direction of the victim receiver, in dBi

EIRP = equivalent isotropically radiated power, in dBW

PL = propagation loss of a signal (desired or undesired) at the victim receiver, in dB.

The location of the minimum D/U value, in both azimuth and elevation, will depend upon the variation of both signals throughout the protected service volume (FIGURE A-1). From Equation A-1, it can be seen that the two main factors affecting those signal levels are propagation loss and antenna gain. Two simplifying assumptions were drawn from preliminary analysis of these variables: 1) when an undesired equipment is located outside the radius of the protected service volume, the minimum D/U location will occur at the farthest range (on the arc) of the service volume, near specific points on the arc; 2) when an undesired equipment is located within a service volume radius of the desired equipment, a conservative minimum D/U value is ensured by using the worst possible D/U value that could occur between those equipments.

The first assumption is based on the calculation of D/U values in the MLS service volume for many positions of the interfering equipments around the service volume. A subset of these D/U calculations is shown for interfering equipments positioned as in FIGURE A-2. The D/U value was calculated at eleven points on the MLS service volume. The azimuth scan beam antenna pattern of FIGURE A-3 was used for the desired signal horizontal antenna pattern, and the DPSK (Ident) pattern of FIGURE A-4 was used as the undesired signal horizontal antenna pattern. The resulting D/U values are documented in TABLE A-1. It can be seen that the minimum D/U value occurs on the service volume arc. In addition, the minimum value occurs near the corner points (1 and 9), or near the closest point to the undesired equipment, when that equipment is positioned within the angular limits of the desired service volume coverage.

To verify that these locations will yield a minimum D/U value for various equipment orientations, a second subset of calculations was performed with the same equipments oriented as shown in FIGURE A-5. The results of these calculations are shown in TABLE A-2. Again, the minimum D/U value occurs on the service volume arc, at either the corner points or the nearest point to the undesired equipment.

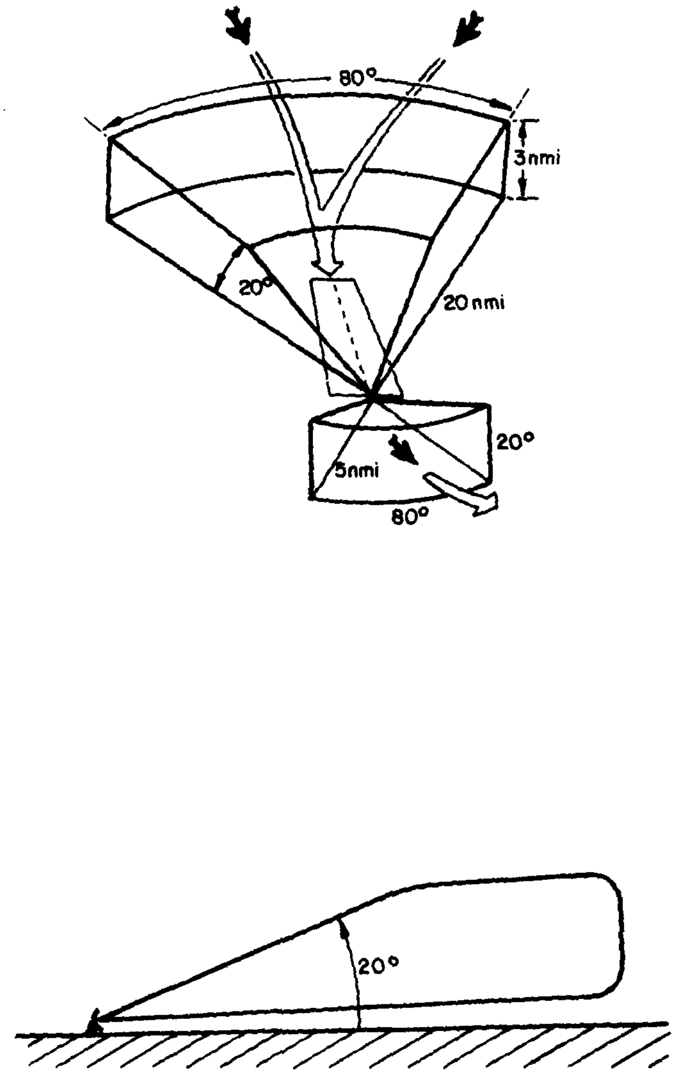


FIGURE A-1. MLS SERVICE COVERAGE.

[6] ICAO Submission by FAA, *Time Reference Scanning Beam Microwave Landing System,* DOT/FAA, December 1970.

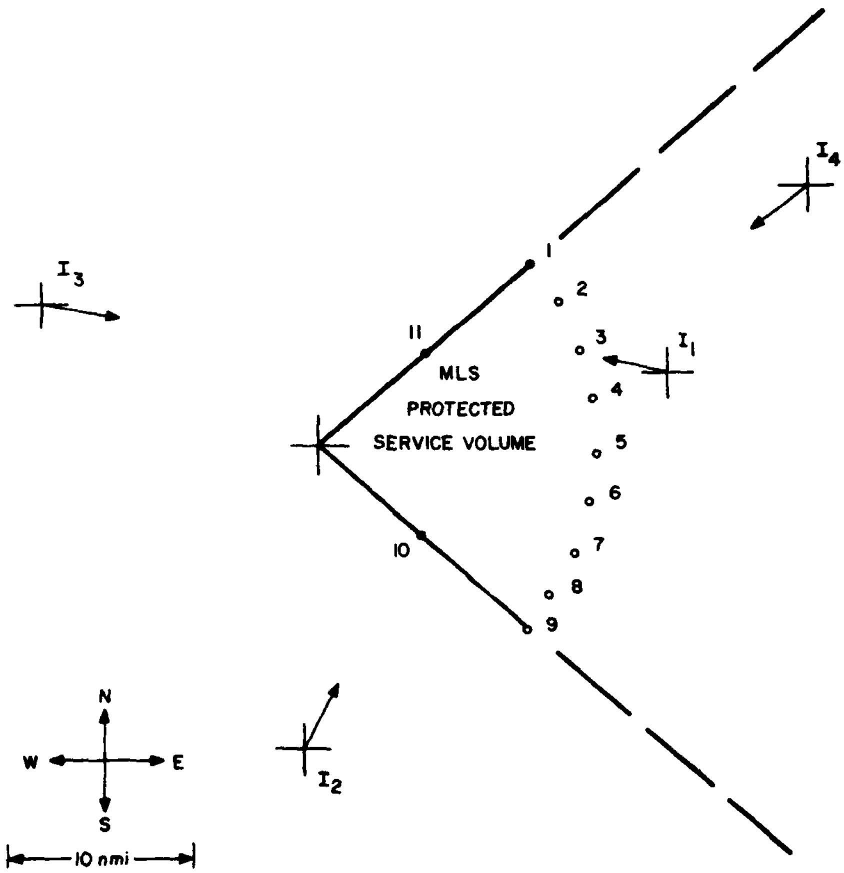


FIGURE A-2. TEST POINT LOCATIONS ON AN MLS SERVICE VOLUME.

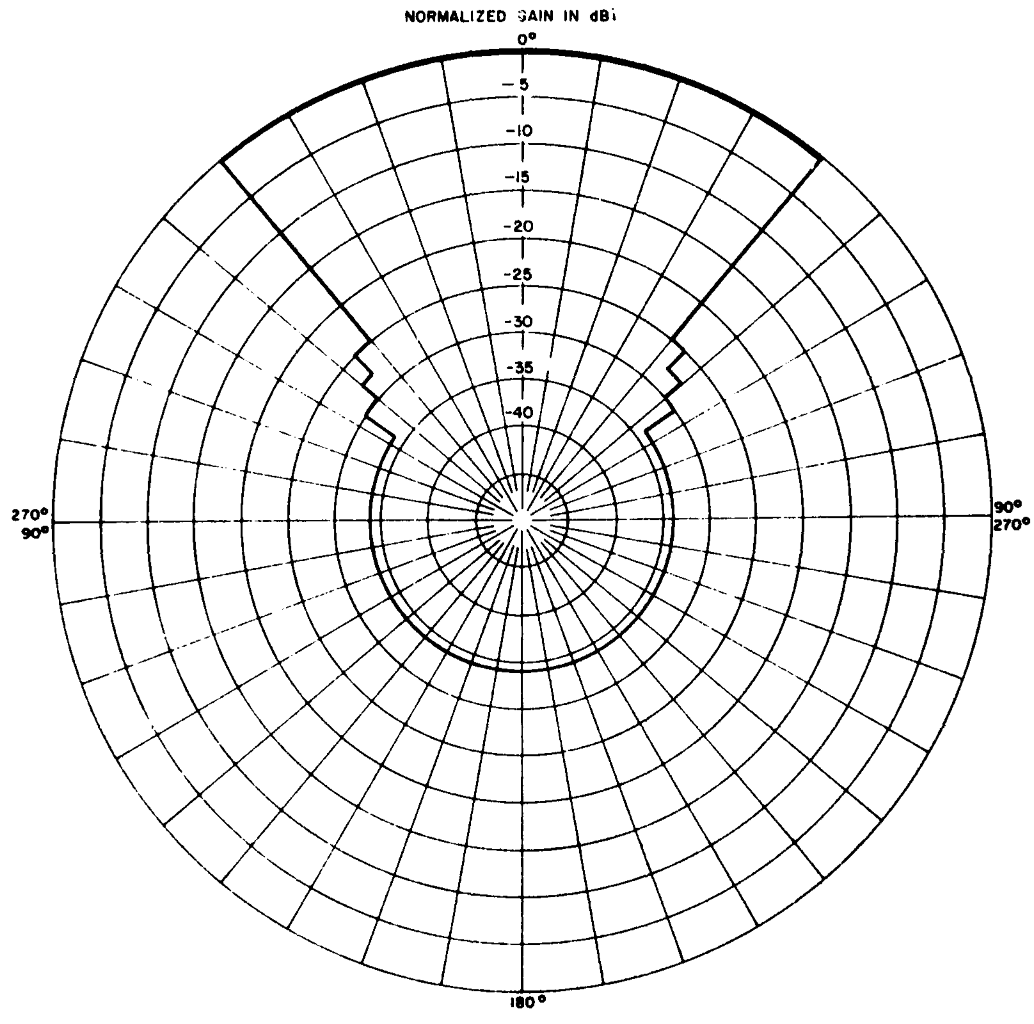


FIGURE A-3. AZIMUTH SCAN BEAM HORIZONTAL ANTENNA PATTERN.

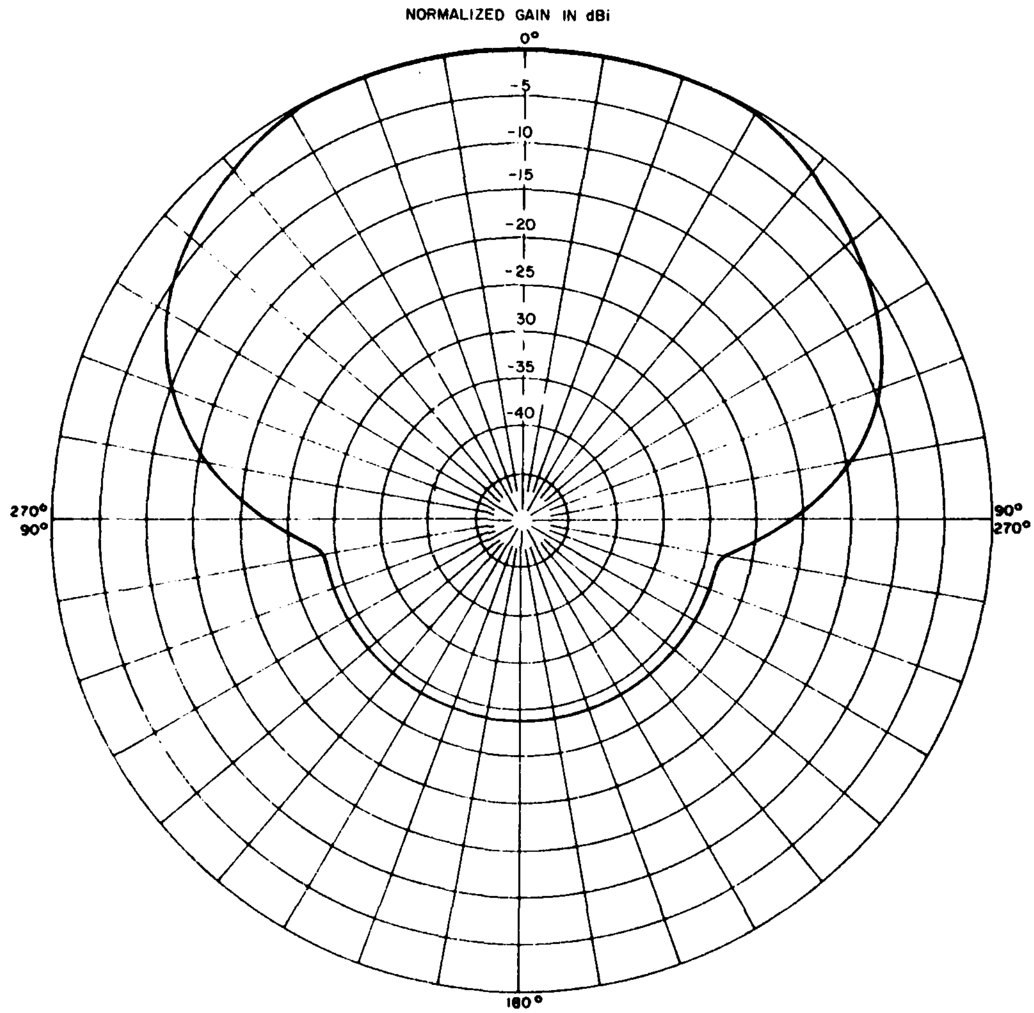


FIGURE A-4. IDENT HORIZONTAL ANTENNA PATTERN.

TABLE A-1

CALCULATED D/U VALUES

D/U @ (dB)	Interferer			
	I_1	I_2	I_3	I_4
1	28.5	10.0	34.5	32.0
2	19.8	12.0	31.0	31.5
3	6.5	14.5	28.5	32.0
4	-5.8	17.0	26.0	32.0
5	-7.0	20.5	23.5	33.0
6	-4.2	24.5	20.5	33.5
7	-0.5	27.5	18.5	34.5
8	-1.5	28.5	16.5	35.0
9	-3.0	31.5	14.5	36.0
10	9.2	15.9	19.0	38.3
11	13.7	18.1	24.5	35.7

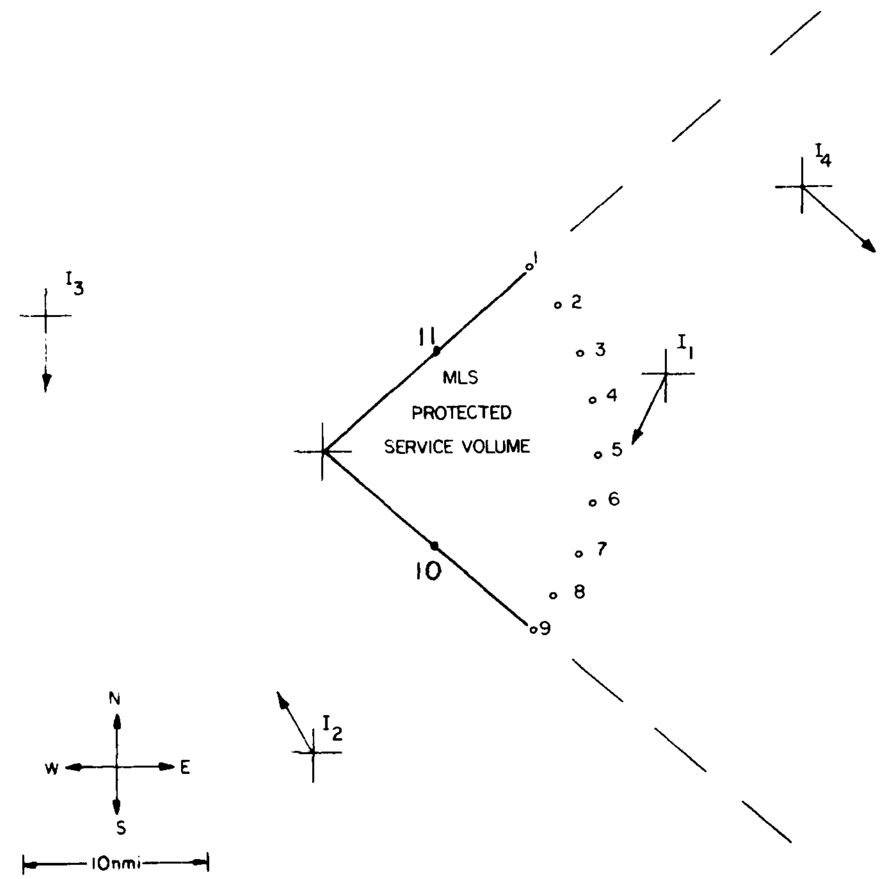


FIGURE A-5. ALTERNATE INTERFERING ORIENTATIONS.

TABLE A-2

CALCULATED D/U VALUES

D/U (dB)	Interferer			
	I_1	I_2	I_3	I_4
1	-0.5	7.8	6.5	3.0
2	-5.2	7.8	7.0	2.5
3	-7.5	6.5	7.5	3.0
4	-8.8	6.0	8.0	3.0
5	1.0	5.5	8.5	4.0
6	7.8	5.0	8.5	4.5
7	14.5	4.5	8.5	5.5
8	16.5	3.5	8.5	6.0
9	18.0	2.0	8.5	7.0
10	13.2	7.9	12.0	13.3
11	6.9	12.1	12.5	11.7

The approach used to calculate these D/U values takes into account the vertical as well as the horizontal antenna variations and propagation loss. This is done using a propagation model developed by the Institute for Telecommunication Sciences (ITS) (Reference 4). This model calculates a D/U value versus equipment separation distance[a] on a 95% time availability basis, based on the propagation losses and normalized vertical antenna gains of the desired and undesired signals in the direction of the victim receiver. This D/U does not account for differences in the equipment power or the normalized horizontal antenna gains. The overall D/U value is determined by correcting the ITS-calculated D/U (D/U_{ITS}) for the differences in transmitter power and horizontal antenna gains of the desired and undesired signals. Rewriting Equation A-1 in terms of the D/U_{ITS}:

$$D/U = (G_D - HG_D + EIRP_D) - (G_U - HG_U + EIRP_U) + D/U_{ITS} \qquad \text{(A-2)}$$

where

D/U_{ITS} = the ratio of desired to undesired signal propagation loss and vertical antenna gains, for a fixed desired-to-undesired separation distance and victim receiver altitude, in dB.

$D/U_{ITS} = VG_U + PL_U - VG_D - PL_D$

It can be seen that the D/U_{ITS} contains those variables, i.e., propagation loss and normalized vertical antenna gain, that vary with respect to the altitude of the victim receiver. To ensure that the overall D/U value is minimized with respect to altitude, the D/U_{ITS} is calculated at the worst-case altitude, for each value of separation distance, and these values are stored in look-up tables for use later in calculating the overall D/U.

[a]The separation distance is the ground distance from the undesired equipment to the victim receiver, plus the ground distance from the victim receiver to the desired equipment.

The process of creating these D/U_{ITS} look-up tables is based on producing a series of D/U_{ITS} curves for several altitudes within the limits of the victim's service volume, and combining these curves by taking the minimum value at each increment of separation distance.

FIGURE A-6 shows a series of D/U_{ITS} curves for a victim receiver at 20 nmi from the desired equipment and at various altitudes. It can be seen that the minimum D/U_{ITS} will occur at higher altitudes for increasing values of separation distance. By combining these curves, taking the minimum D/U for each value of separation distance, it is possible to produce a single curve that minimizes both the propagation loss and vertical antenna gain ratios for the desired and undesired signals (FIGURE A-7). Using this curve, in a tabulated form, the intersite model obtains a D/U_{ITS} value that reflects the minimized propagation losses and vertical antenna gains by calculating the separation distance through a point on the service volume arc, and obtaining the corresponding D/U_{ITS} value from the proper look-up table.

The second assumption is based on the premise that, by assuming that the worst-case interference will occur when an undesired equipment is located within the circle inscribed by the victim's service volume radius, a conservative minimum D/U value will be used for all those equipments. This worst-case interference is defined by the equipment protection criteria (Appendix C) as the lowest possible D/U value that can occur between interfering equipments. The considerations in determining this worst-case value are described in Reference 9 of Appendix C.

The overall intersite analysis approach developed as the complexity of the task involved. It was necessary to use an analysis that could universally handle all the service volumes and antenna patterns used in the assignment system, and be implemented in a reasonable time period. As the total assignment system is exercised, it may become apparent that the conservative approach used within the service volume radius restricts the assignment of equipments. Refinement of the intersite model to produce correct results for interfering equipments within the

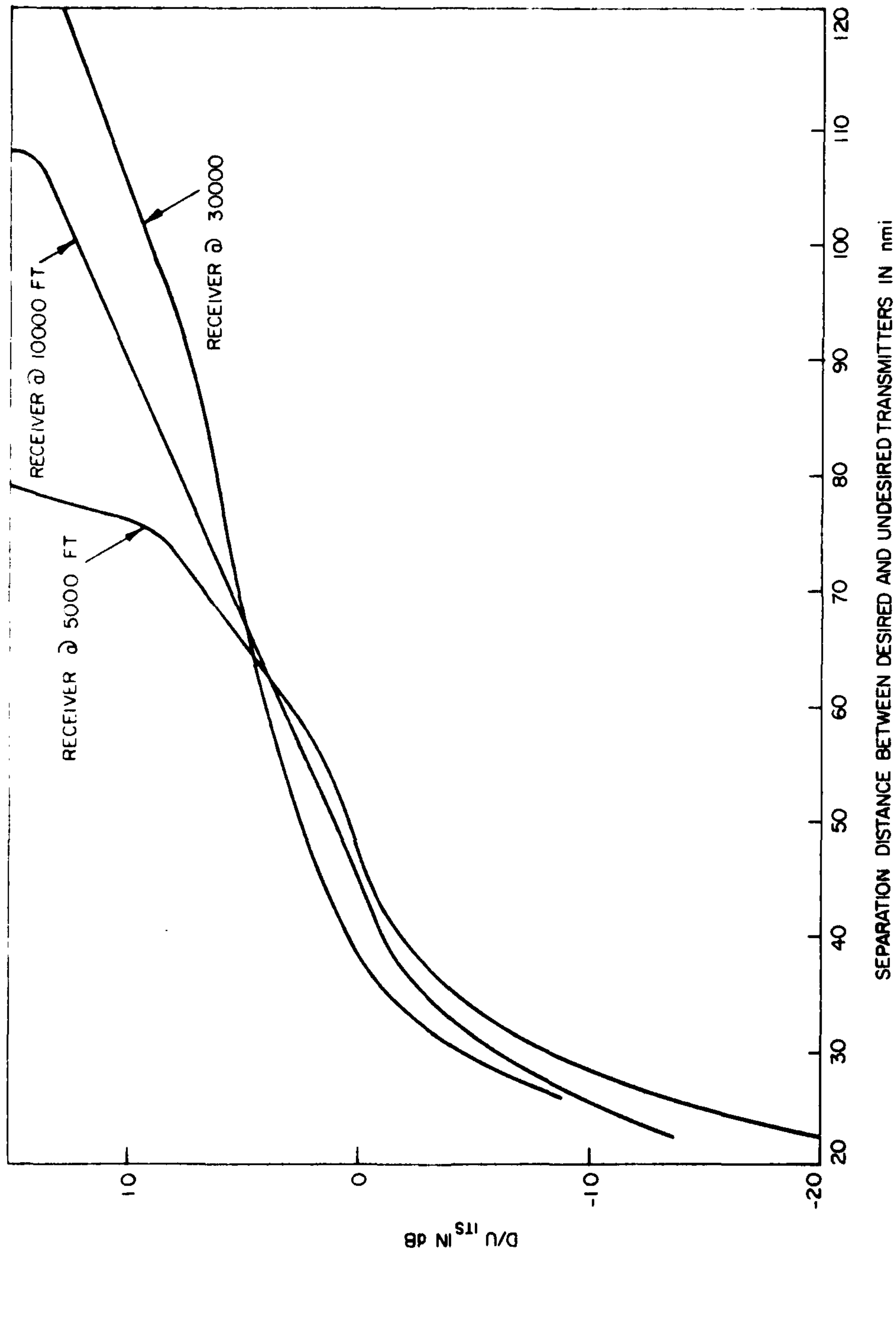


FIGURE A-6. D/U_{ITS} PLOTS AT VARIOUS RECEIVER ALTITUDES.

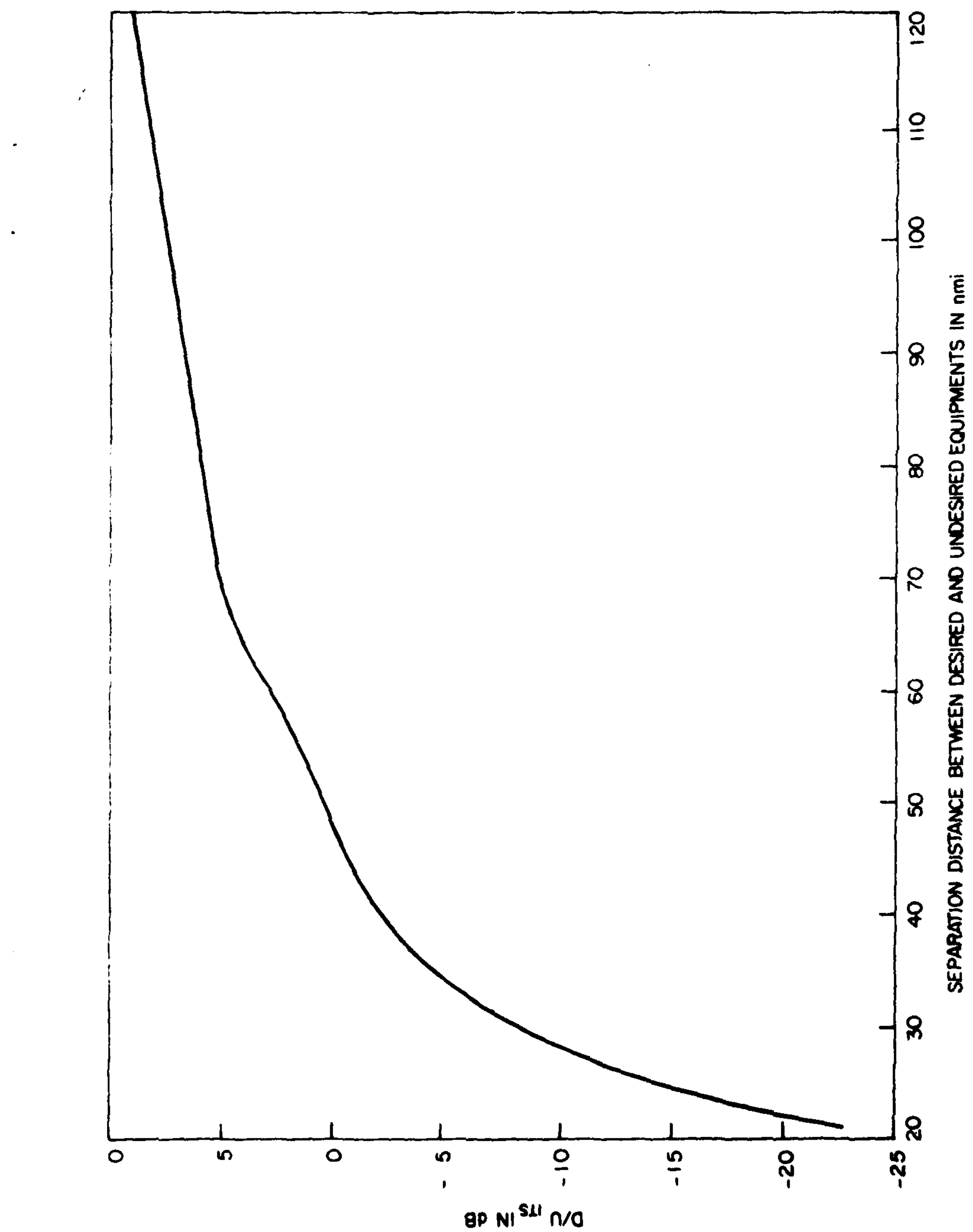


FIGURE A-7. COMPOSITE D/U_{ITS} CURVE FOR 5,000, 10,000, 20,000 FEET ALTITUDES victim service volume radius would involve calculating D/U values at a greater number of points. The scheme would be similar to that shown in FIGURE A-8. For the interfering equipment (I) shown, a D/U calculation would be made at several points, A-G, along the service volume radius, in addition to the points used on the arc. The number of additional calculations necessary would depend on the directionality of the horizontal antenna pattern of the interfering equipment.

In its present form, the intersite routine contains the necessary capability to accommodate a variety of refinements. As it becomes clear that additional capabilities would be beneficial, the routine can be altered.

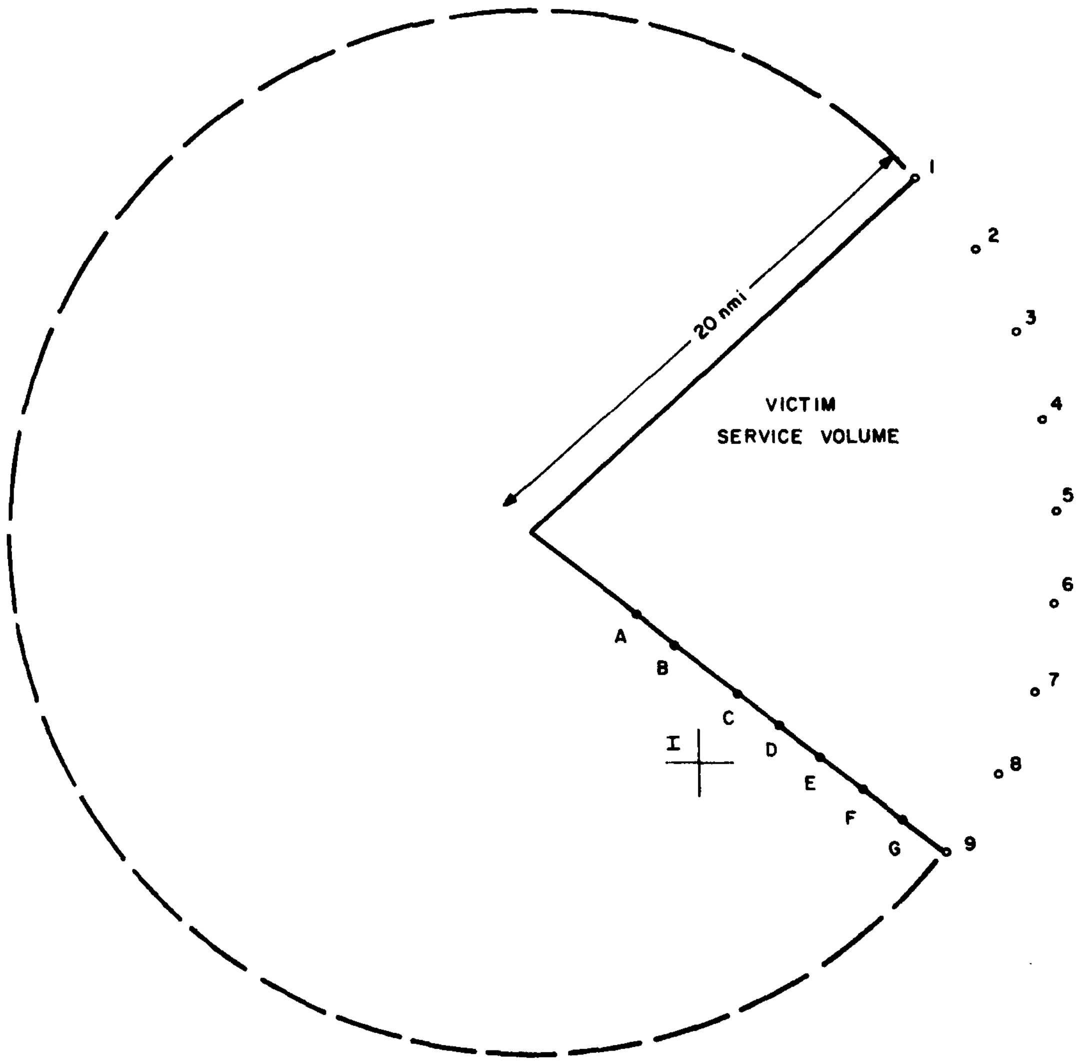


FIGURE A-8. REFINED INTERSITE ANALYSIS.

APPENDIX B

SYSTEM DESCRIPTIONS

This appendix contains a description of the Microwave Landing System (MLS) angle-guidance functions and associated Precision Distance Measuring Equipment. A section is included summarizing the functions, service options, and system parameters to be used for each equipment in the assignment model.

MLS ANGLE GUIDANCE

Angle Guidance (Reference 6)

The TRSB signal format is based on the TO-FRO scanning beam technique, in which narrow fan beams scan through the coverage volume in alternate directions. The beams are scanned at high speed and consist of a single, unmodulated, continuous radio frequency transmission. The scanning speed is uniform, starting from one extremity of the coverage sector and moving to the other and then back again to the starting point, thus producing a TO-FRO scan as shown in FIGURE B-1 for azimuth. The azimuth beam scans first counterclockwise and then clockwise, as viewed from above. The elevation beam scans first down and then up. In every scanning cycle, two pulses are received by the aircraft. The time interval between the TO and FRO pulses is proportional to the angular position of the aircraft with respect to the runway centerline. An important feature of the time reference encoded scanning beam system is the high data update rate, 13.5 Hz for azimuth and 40.5 Hz for elevation. These data rates make it possible to design simple airborne processors that can minimize multipath effects on guidance signals.

All angle and data functions are time-multiplexed on the assigned radio frequency so that a single receiver-processor channel may process all data. Since each function is an independent entity in the time-multiplexed function sequence, the receiver may decode functions in any sequence. This is accomplished by providing each function with a preamble that, upon reception, sets the receiver for the function which follows. The function identification preamble is radiated on

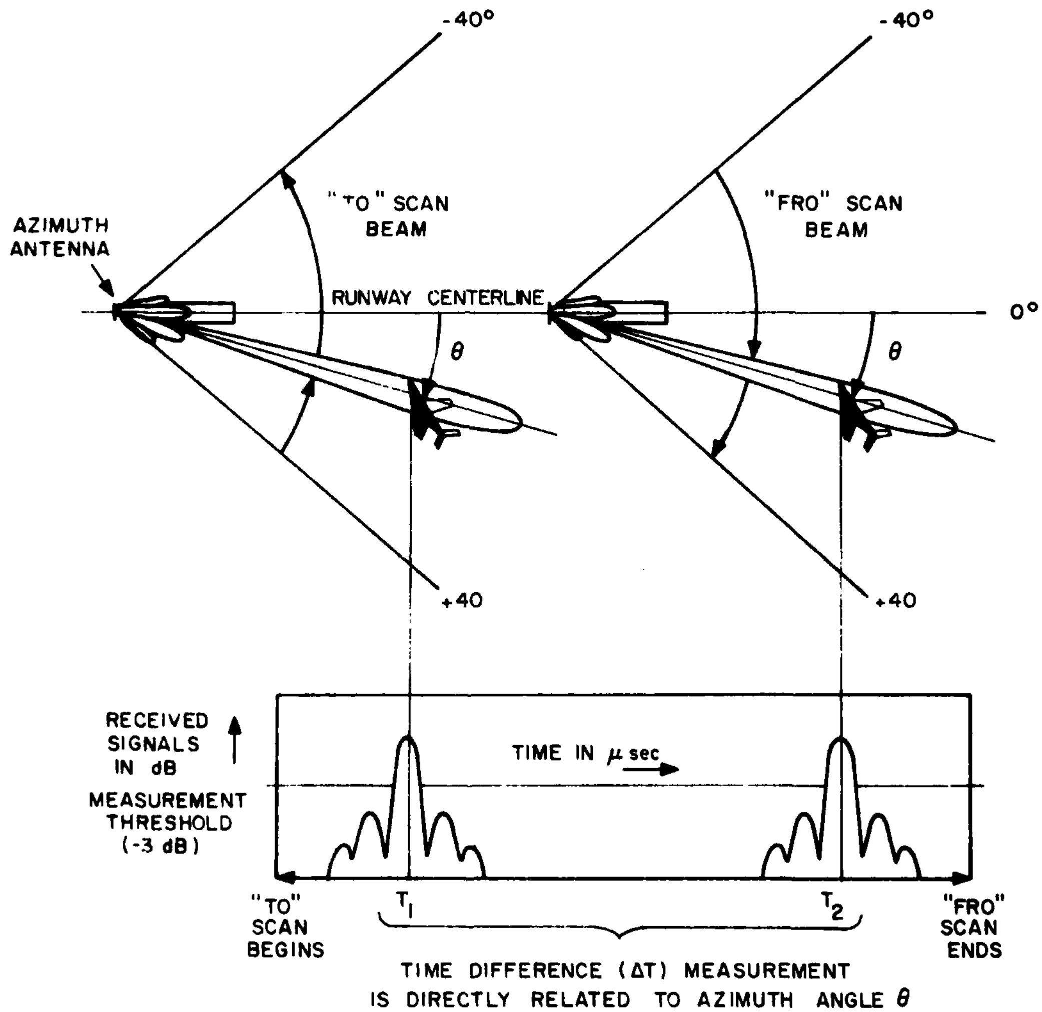


FIGURE B-1. TIME DIFFERENCE MEASUREMENT.

a sector antenna covering the function guidance volume. The scanning fan beam and the sector transmission are illustrated in FIGURE B-2.

FIGURE B-2. REPRESENTATION OF THE ANGLE AND PREAMBLE RADIATION CHARACTERISTICS.

All angular information is essentially linear throughout the volume of coverage. Precision azimuth angle guidance is provided to at least ±40°, or a narrower sector if desired. For any installation, and particularly where proportional coverage is reduced for reasons of economy, left-right guidance information may be provided over a wider sector. Precision elevation angle guidance, referenced to a standard reference point, is provided from 1° to 20° in elevation, over the same sector that provides azimuth angle guidance. Precision missed-approach azimuth angle guidance, referenced to runway centerline, is provided to at least ±20°.

The proposed standard signal format contains a time slot for the addition of 360° azimuth and missed-approach elevation guidance to meet potential future requirements, and the design concept is sufficiently flexible to permit the implementation of alternate means for providing a 360° azimuth capability for particular national requirements. Such an alternative could be implemented at C-band or Ku-band with either electronic or mechanically scanned antennas and could be made compatible with standard receivers by a simple processor augmentation.

Signal Format[a]

The TRSB signal format defines details of the signals-in-space provided by MLS. The unique signal format concepts affecting operational and performance characteristics of TRSB are discussed below:

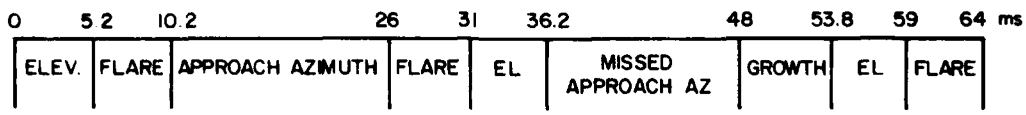
1. 200-independent-channel capability for angle and range.
2. Time Division Multiplex (TDM) operation of all TRSB functions per channel such that only one MLS transmitter is operational at any one time and only one receiver processor channel is required to decode angle guidance information.
3. A large number of samples per second to permit data averaging.

By employing the TDM format with a unique identification for each function, functions can be easily added to or deleted from the signal format to accomodate specific runway requirements. In this way the format provides a high degree of flexibility and growth capability to accommodate potential future requirements for additional MLS functions or auxiliary data messages. Functions provided by the signal format are:

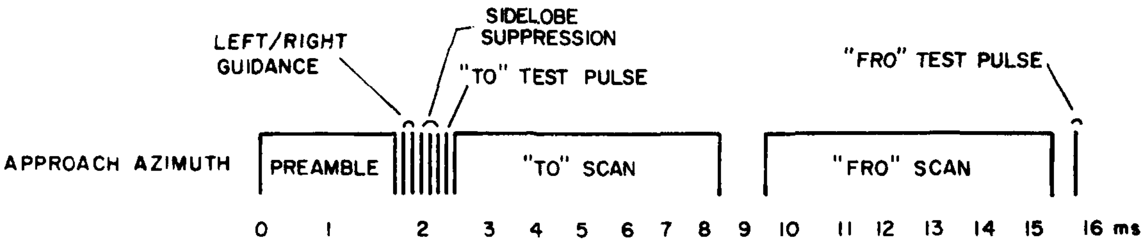
1. Function preamble including function identification.
2. Auxiliary data (e.g., Site Geometry, Status of Subsystems, etc.).
3. Approach azimuth angle guidance.
4. Elevation angle guidance.
5. Missed-approach azimuth angle guidance.
6. Missed-approach/departure elevation guidance.
7. Flare angle guidance.
8. 360° azimuth guidance.
9. left-right guidance.
10. Sidelobe suppression.
11. Ground test signal.
12. Independent range guidance.

[a] pp 1-2.5 to 1-2.7 of Reference 6.

Part of a typical scan cycle is shown in FIGURE B-3. Each function is transmitted in time sequence and is differentiated from other functions by the function preamble preceding each function transmission. The preamble is radiated throughout the coverage volume on a sector antenna and contains function synchronization and identification information in the form of differentially phase-shift-keyed (DPSK) digital signals. This function preamble is followed by left-right guidance pulses, sidelobe suppression pulses, ground test pulses, and TO-FRO angle fan beams.



(a) Multiplexed Functions



(b) Sequence for Approach Azimuth Function

FIGURE B-3. TIME DIVISION MULTIPLEX OF FUNCTIONS

Angle guidance information is derived from narrow scanning fan beams. These beams sequentially encode all angles in the coverage sector. All other functions (function preamble, auxiliary data, etc.) are broadcast on wide-coverage sector antennas.

Another key feature of the signal format is the high data rates provided to permit data averaging. This averaging reduces the effect of in-beam multipath signals which cannot be eliminated by other forms of receiver processing. High sample rates are realized with electronically scanned antennas.

The signal format is designed such that at a runway providing maximum MLS service, all angle functions are combined on a single-frequency channel, while airports with more modest service requirements use the same signal format but radiate only selected functions. This flexibility provides for complete interoperability of all ground and airborne equipments, with the resulting service limited by the lesser capabilities of either the ground or airborne equipment.

Configurations

There are six MLS system configurations designed to provide a variety of performance levels to meet the needs of civil and military users. The three civil systems are the Small Community, the Basic and the Expanded. The remaining three systems are future military systems. At present the basic civilian system fulfills the requirements of fixed military bases. The performance capabilities of the civilian systems are shown in TABLE B-1.[7]

The Small Community configuration provides a minimum level of service, limited proportional or angle guidance, and less stringent accuracy requirements. The Basic configurations have several azimuth and elevation antenna beamwidth options. The wide aperture antenna configuration provides narrow beamwidths yielding higher accuracy. The narrow aperture antenna configuration provides broader beamwidths with lower accuracy. The Expanded configuration provides the complete range of angle coverage available including flare touchdown guidance, and missed approach or back azimuth.

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[7] *National Plan for Development of the Microwave Landing System*, FAA-ED-07-2A, DOT/FAA, June 1978.

TABLE B-1

PERFORMANCE CAPABILITIES OF MLS CONFIGURATIONS
(FROM REFERENCE 7)

Configuration			Basic					
Function	Expanded		Wide Aperture		Narrow Aperture		Small Community	
	BW[a]	Coverage	BW	Coverage	BW	Coverage	BW	Coverage
Azimuth	1°	±40° proportional guidance	1°	±40° proportional guidance	2°	±40° proportional guidance	3°	±40° proportional guidance ±40° sector guidance
Elevation	1°	0° to 20° proportional guidance	1°	0° to 20° proportional guidance	1.5°	1° to 10° proportional guidance	2°	1° to 10° proportional guidance
Flare	0.5°	8 feet above runway to 8.5° proportional guidance	NA	NA	NA	NA	NA	NA
Missed Approach Azimuth	3°	proportional guidance	NA	NA	NA	NA	NA	NA
Identification	NA	±40°	NA	±40°	NA	±40°	NA	±40°

[a]Antenna - 3 dB beamwidth.

MLS PRECISION DISTANCE MEASURING EQUIPMENT

The MLS Precision Distance Measuring Equipment (PDME), operating in the 960-1215 MHz region, is an evolution of the conventional DME system. Increased accuracy is gained through pulse shape modification. As with conventional DME, the system consists of a transponder on the ground and an interrogator in the aircraft. Distance information is derived in a manner similar to that of the conventional TACAN/DME system.

The PDME is designed to be completely interoperable with conventional DME equipments and should meet the increased operational requirements that the MLS angle-guidance functions demand,which are an order of magnitude greater than those placed on the conventional DME.

To obtain the ±100 feet range accuracy necessary during Category III[a] landing, modification of the signal format and design of the conventional DME equipment was necessary. The signal format was modified by sharpening the leading edge of the first pulse of each pulse-pair. The cos/cos^2 pulse shape chosen has a cosine shape for the leading edge of the first pulse and a cos^2 or gaussian shape for the trailing edge.

The conventional DME equipment concept was modified to allow for the detection of the sharper rising pulse, to more closely control the system delay time, and to improve rejection to co- and adjacent channel signals.

The PDME is a multimode system capable of operating with various pulse-pair spacings for both the ground-to-air and air-to-ground transmissions. The PDME can be multiplexed onto available DME channels in X- and Y- modes.

SYSTEM PARAMETERS

This section summarizes the important equipment functions and operational parameters necessary to exercise the channel-assignment model. The actual

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[a] 0 feet ceiling, 0 nmi visibility.

working environment may contain a much wider range of parameters than detailed here. The information in TABLE B-2 was chosen to represent a conservative but realistic working environment. The choice of functions and parameters to determine worst-case situations as well as the protection criterion is described in APPENDIX C.

TABLE B-2

EQUIPMEMT PARAMETERS

Equipment	Function	Configuration Option	Service Volume Options	Frequency	Vertical Antenna Pattern	Horizontal Antenna Pattern	ERP (dBm)
MLS Angle Guidance	Ident.	Sm. Comm. Basic Expanded	Figure B-4	5.0-5.25 GHz	Ident. Elevation Figure B-5	Ident. Azimuth Figure B-6	49.0
	Azimuth Scan-Beam			5.0-5.25 GHz	Scan-Beam Elevation Figure B-5	Scan-Beam Azimuth Figure B-7	54.0
ILS	Localizer	Standard Option 1 Option 2 Option 3	Figure B-8	108-112 MHz	Cosine	Wilcox Figure B-9 or 8-Loop Figure B-10	62.0 or 54.0
	Glideslope			331-334 MHz		Null Figure B-11	42.5
VOR	NA[a]	High Low Terminal	Figure B-12	108-112 MHz		Omni-direction	46.0 or 34.0
TACAN	NA			960-1215 MHz	RTA-2 Figure B-13		73.0
DME	VOR/DME				CHU Figure B-14		41.4
	ILS/DME	Approach And Landing	Figure B-8				31.4
PDME	MLS/DME	Approach And Landing	Figure B-15		PDME Figure B-16	Omni/Sector	55.5

[a]NA - not applicable.

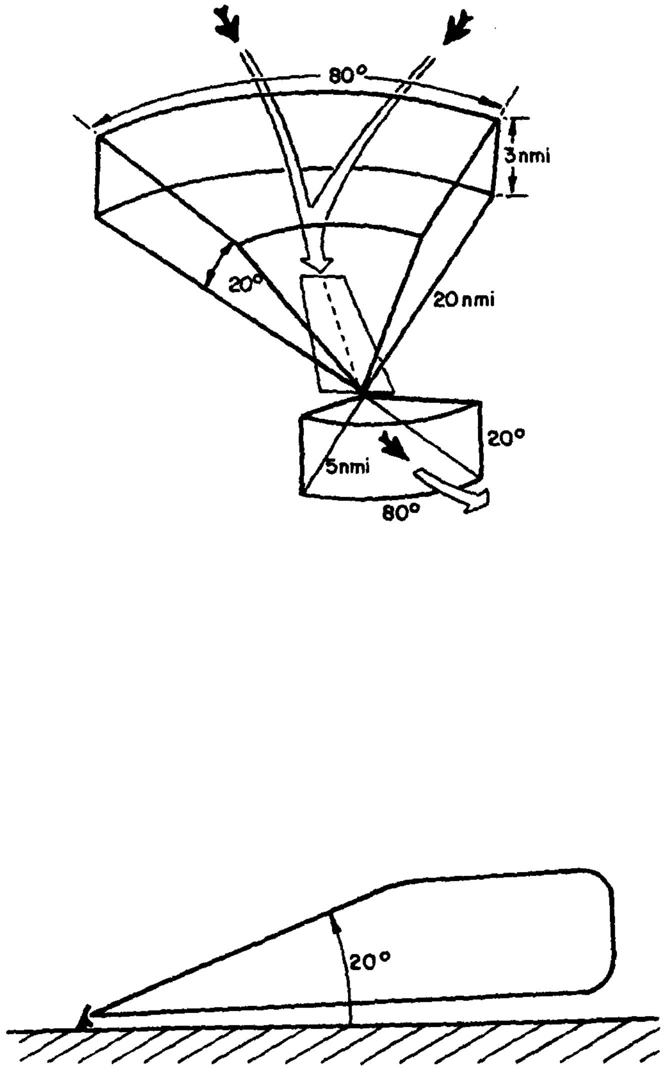


FIGURE B-4. MLS SERVICE VOLUME CONFIGURATIONS.

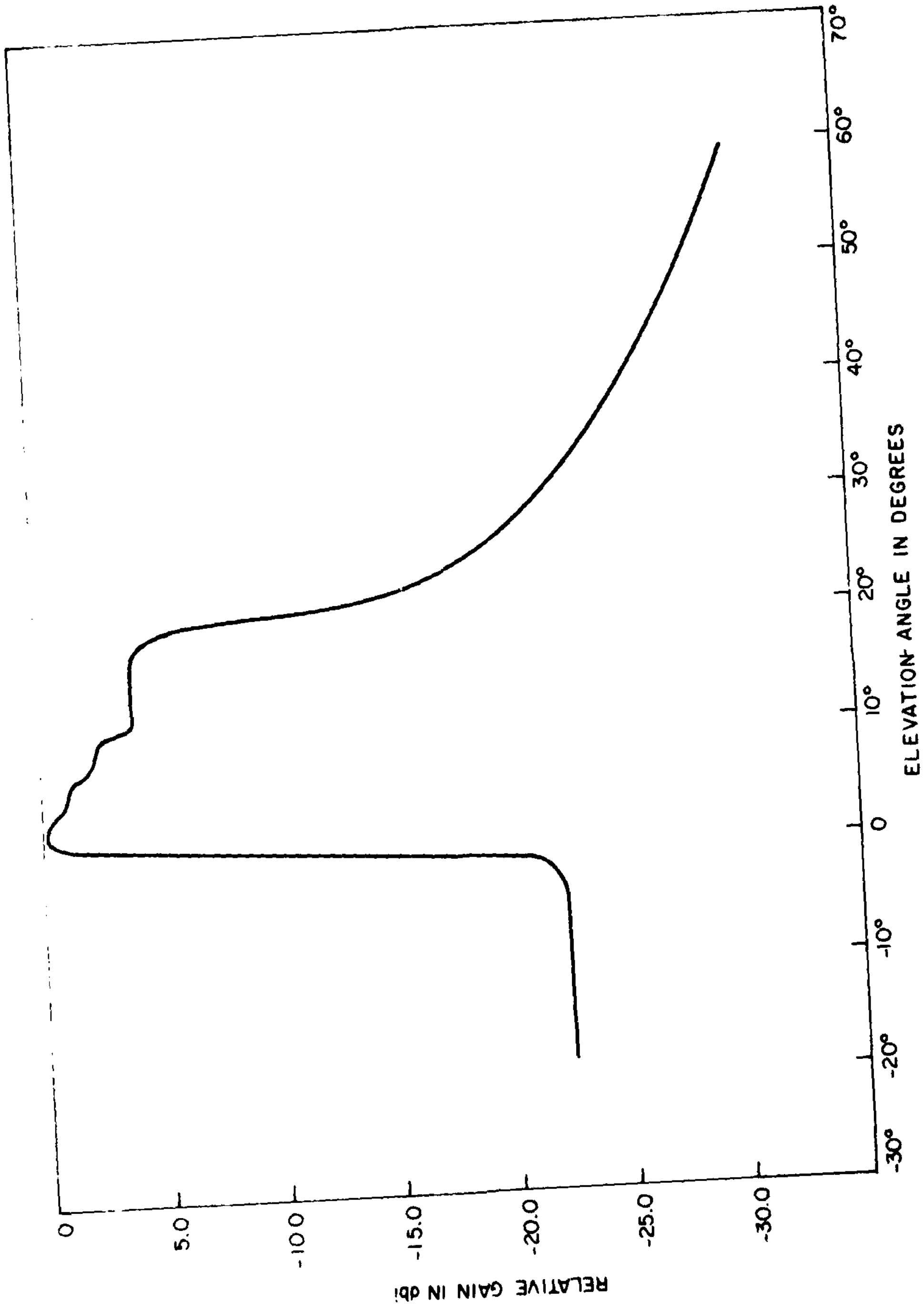


FIGURE B-5. MLS ANGLE GUIDANCE VERTICAL ANTENNA PATTERN.

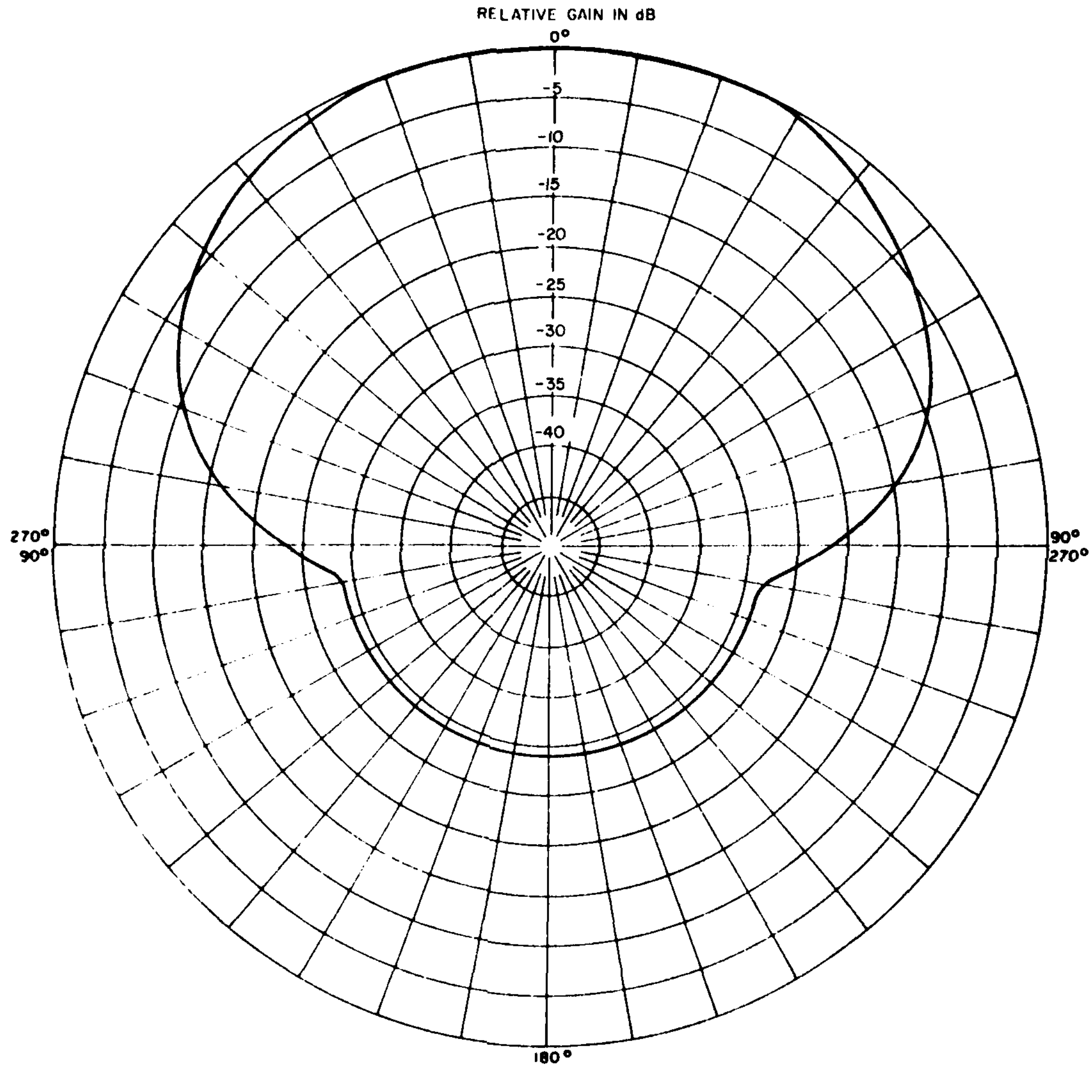


FIGURE B-6. IDENT HORIZONTAL ANTENNA PATTERN.

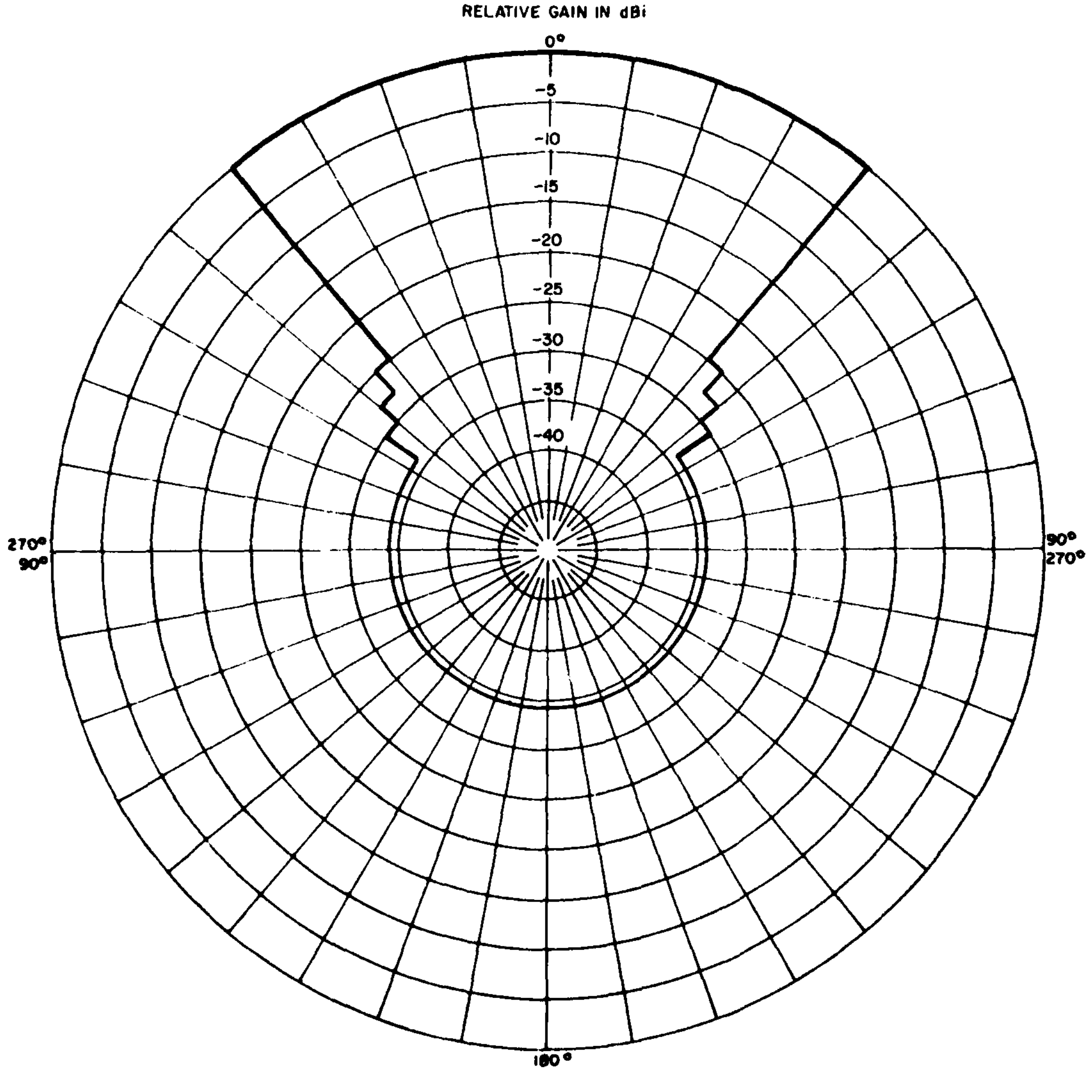
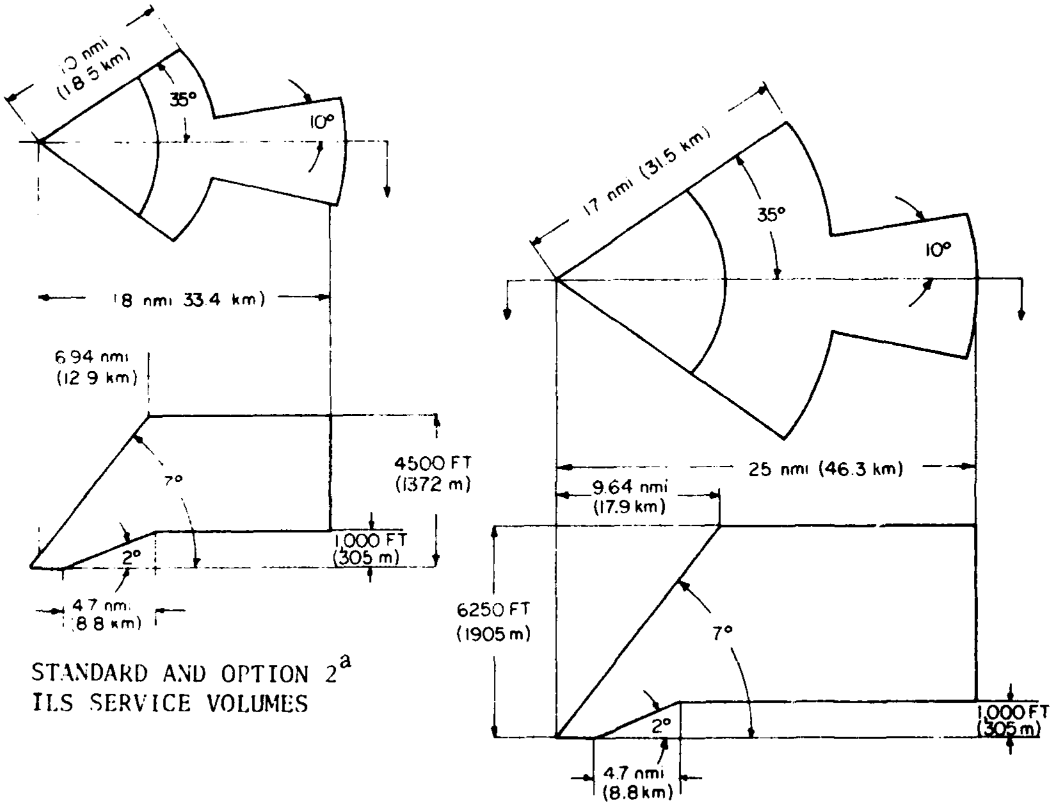


FIGURE B-7. AZIMUTH SCAN-BEAM HORIZONTAL ANTENNA PATTERN.



STANDARD AND OPTION 2[a]
ILS SERVICE VOLUMES

OPTION 1 AND OPTION 3[a]
ILS SERVICE VOLUMES

[a] OPTION 2 PROVIDES THE FULL FRONT AND BACK COVERAGE SHOWN

FIGURE B-8. ILS SERVICE VOLUME OPTIONS.

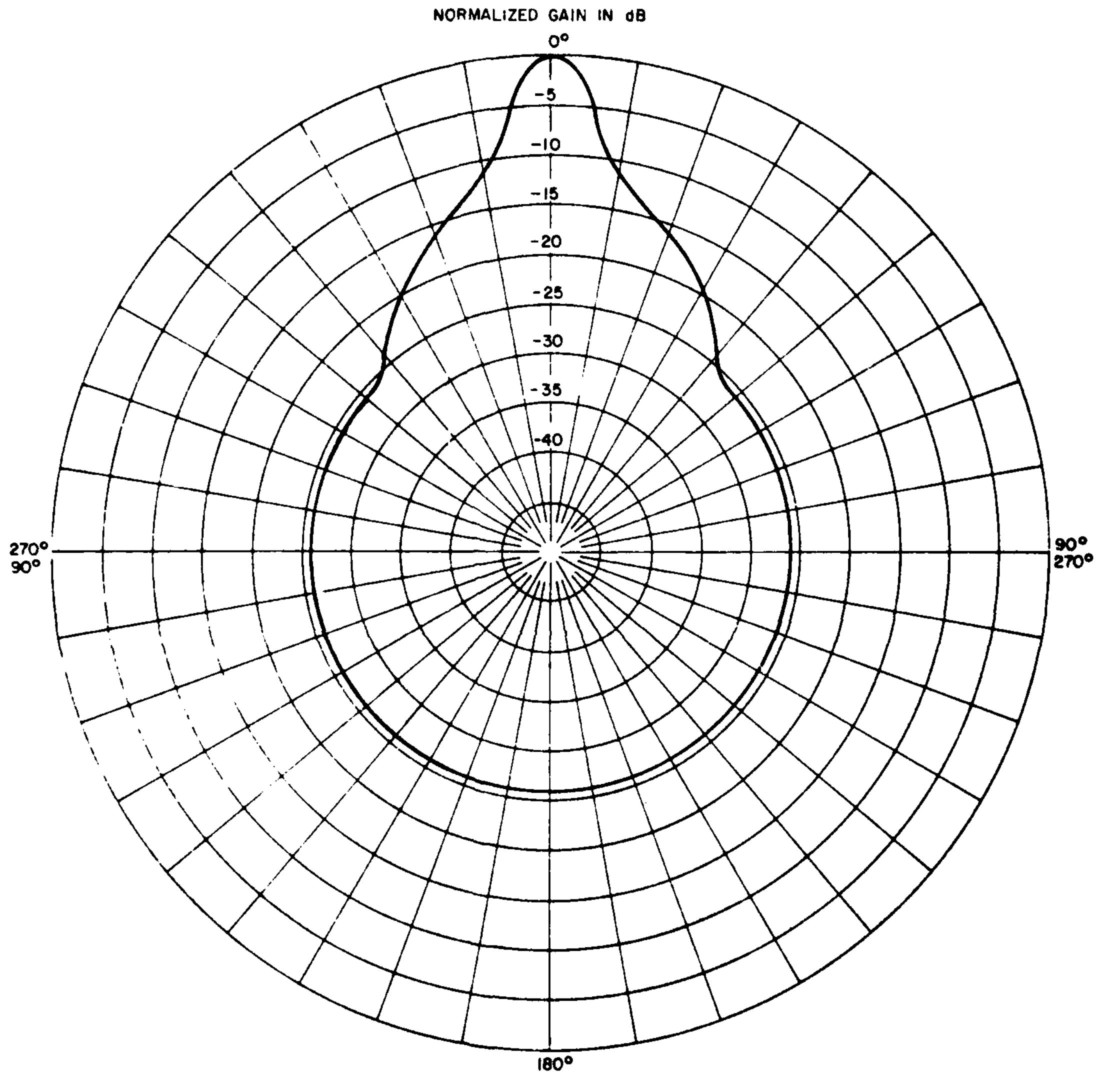


FIGURE B-9. ILS (WILCOX) HORIZONTAL ANTENNA PATTERN.

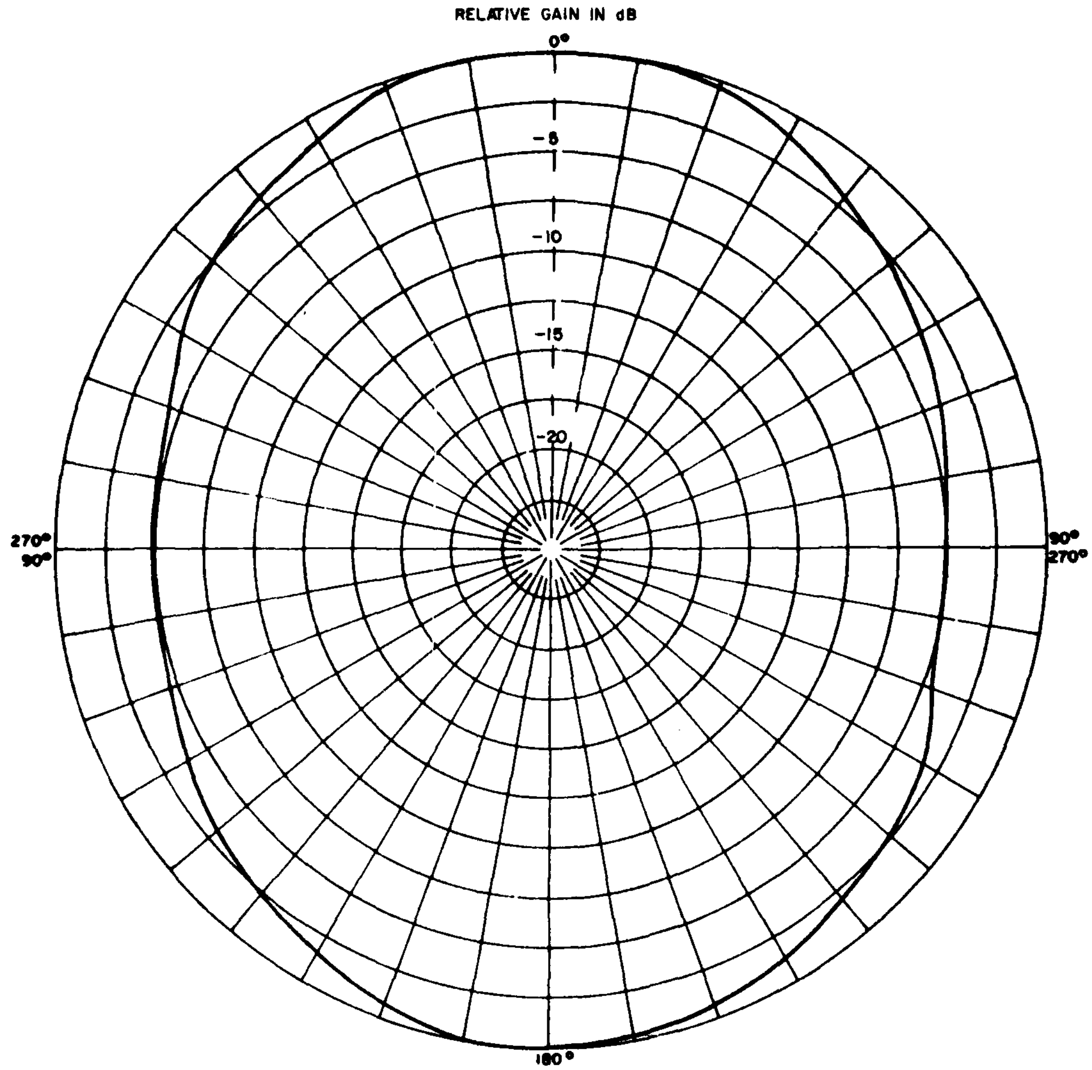


FIGURE B-10. ILS (8-LOOP) HORIZONTAL ANTENNA PATTERN.

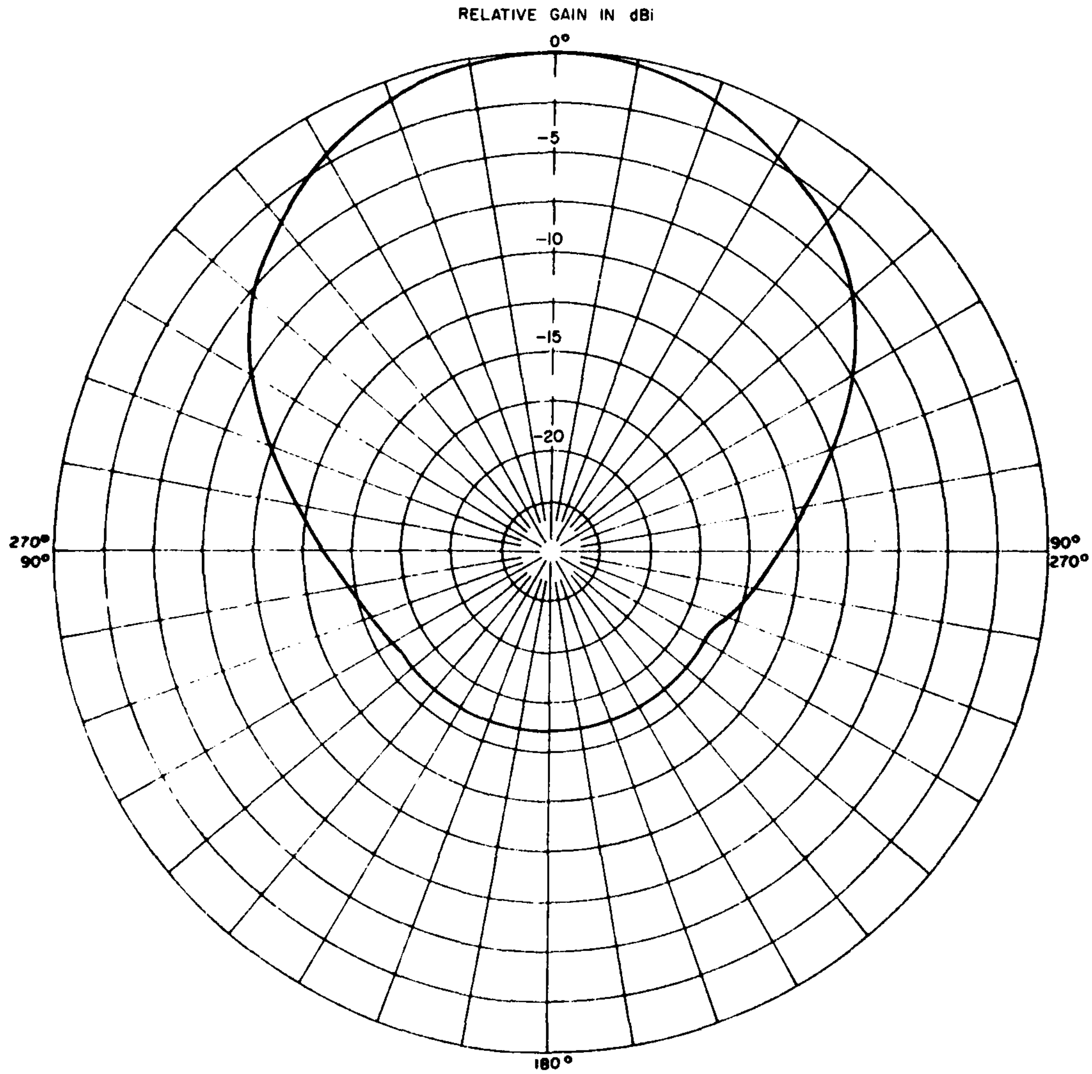


FIGURE 11. ILS GLIDESLOPE ANTENNA PATTERN.

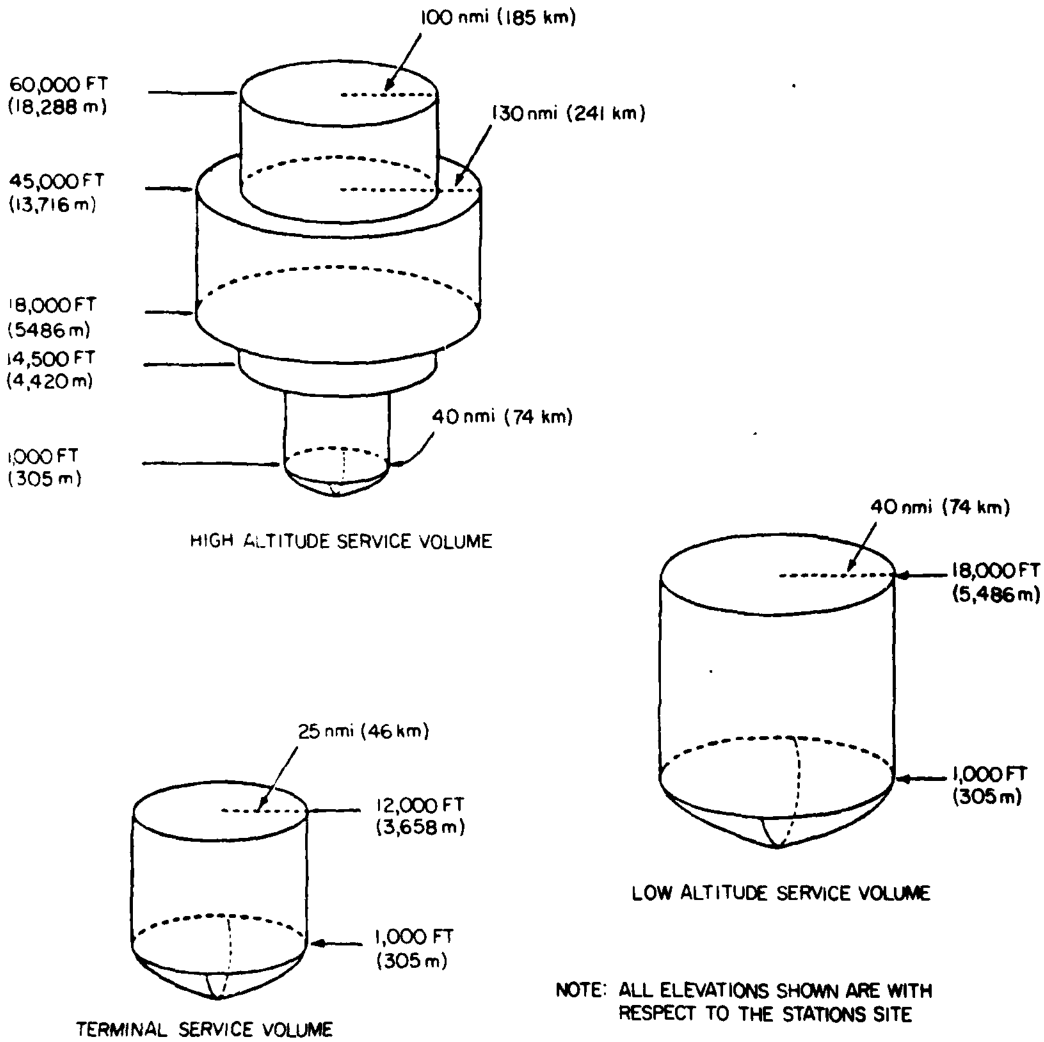


FIGURE B-12. L-BAND SERVICE VOLUME OPTIONS.

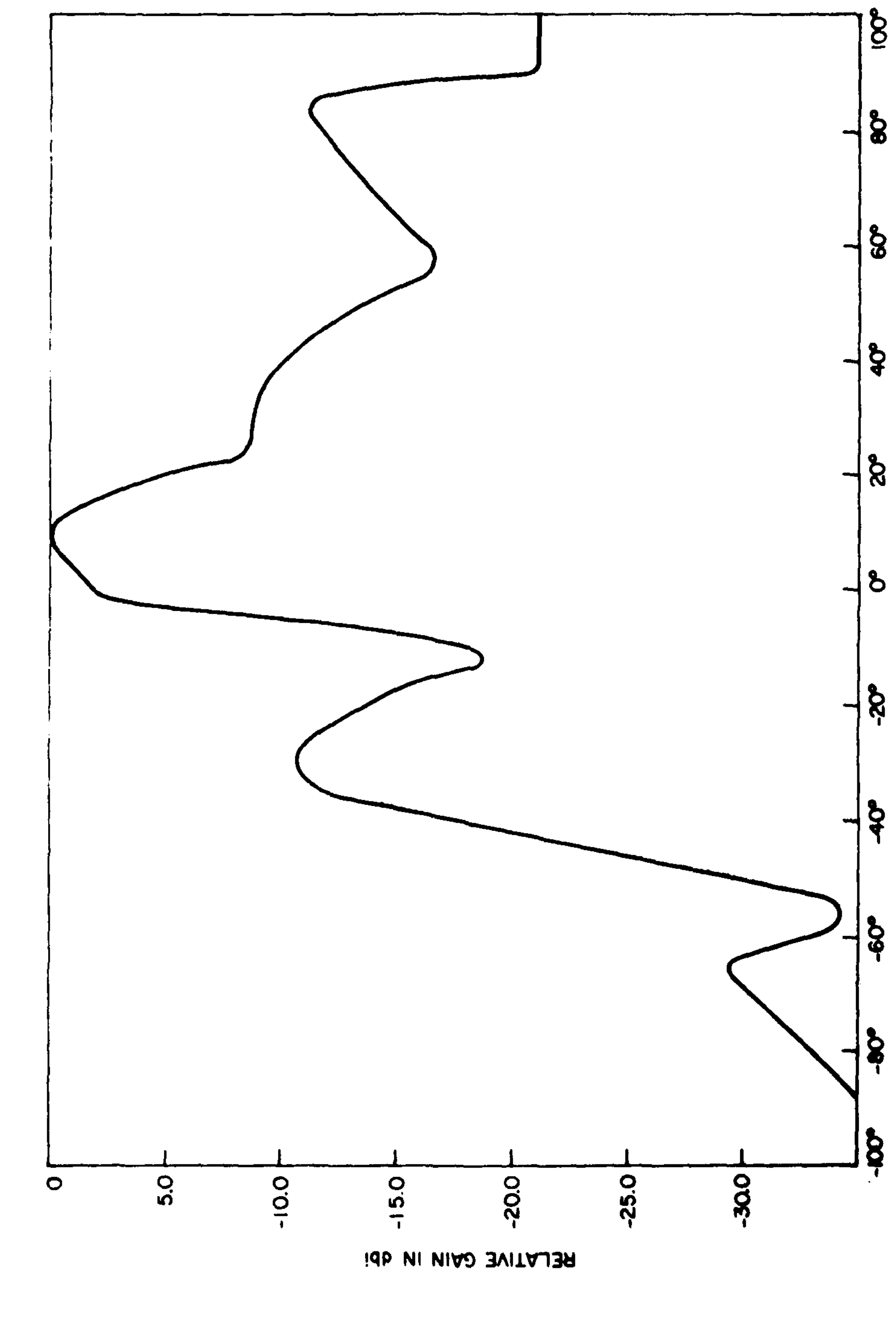


FIGURE B-13. RTA-2 VERTICAL ANTENNA GAIN.

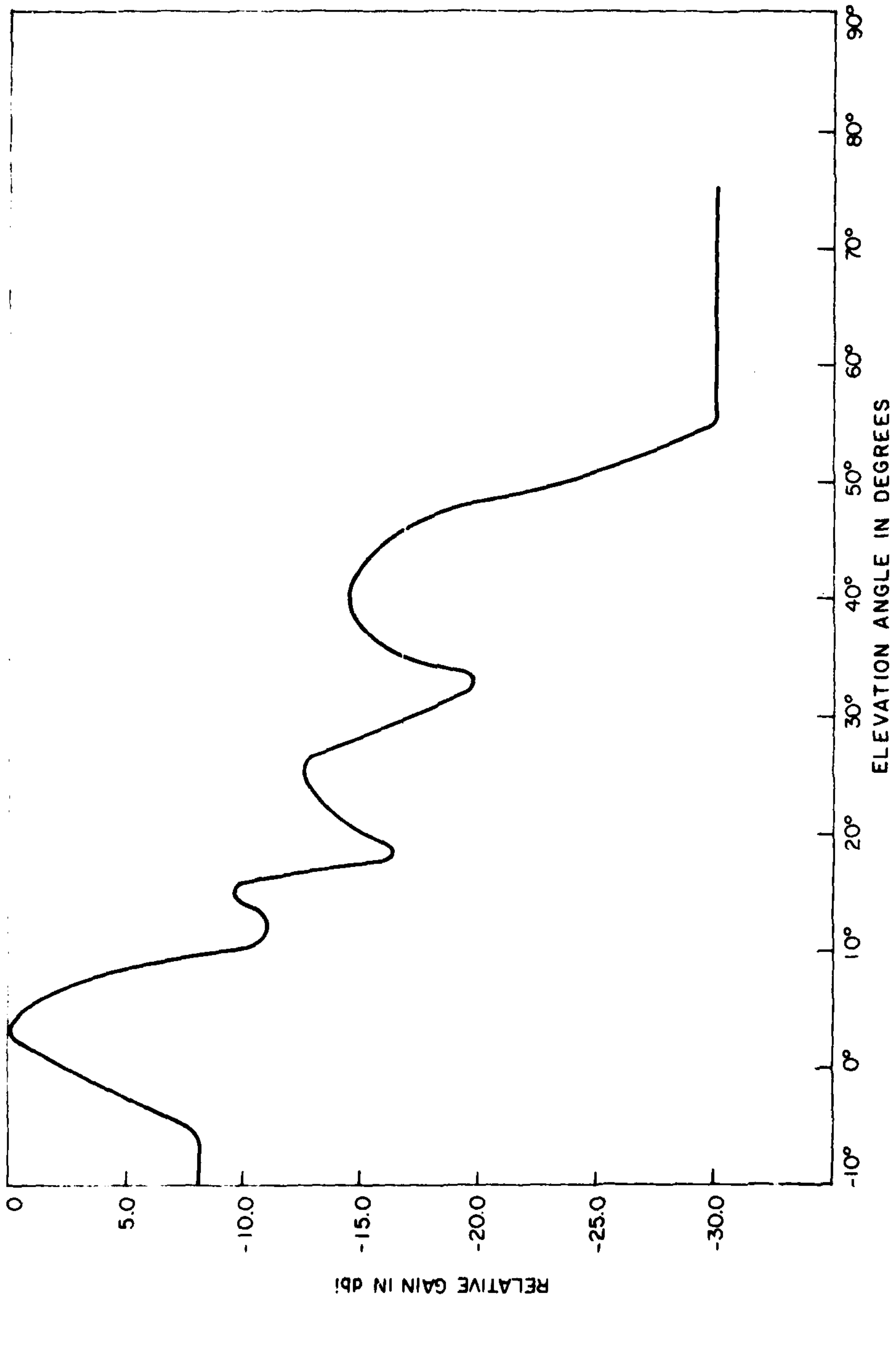


FIGURE B-14. CHU VERTICAL ANTENNA PATTERN.

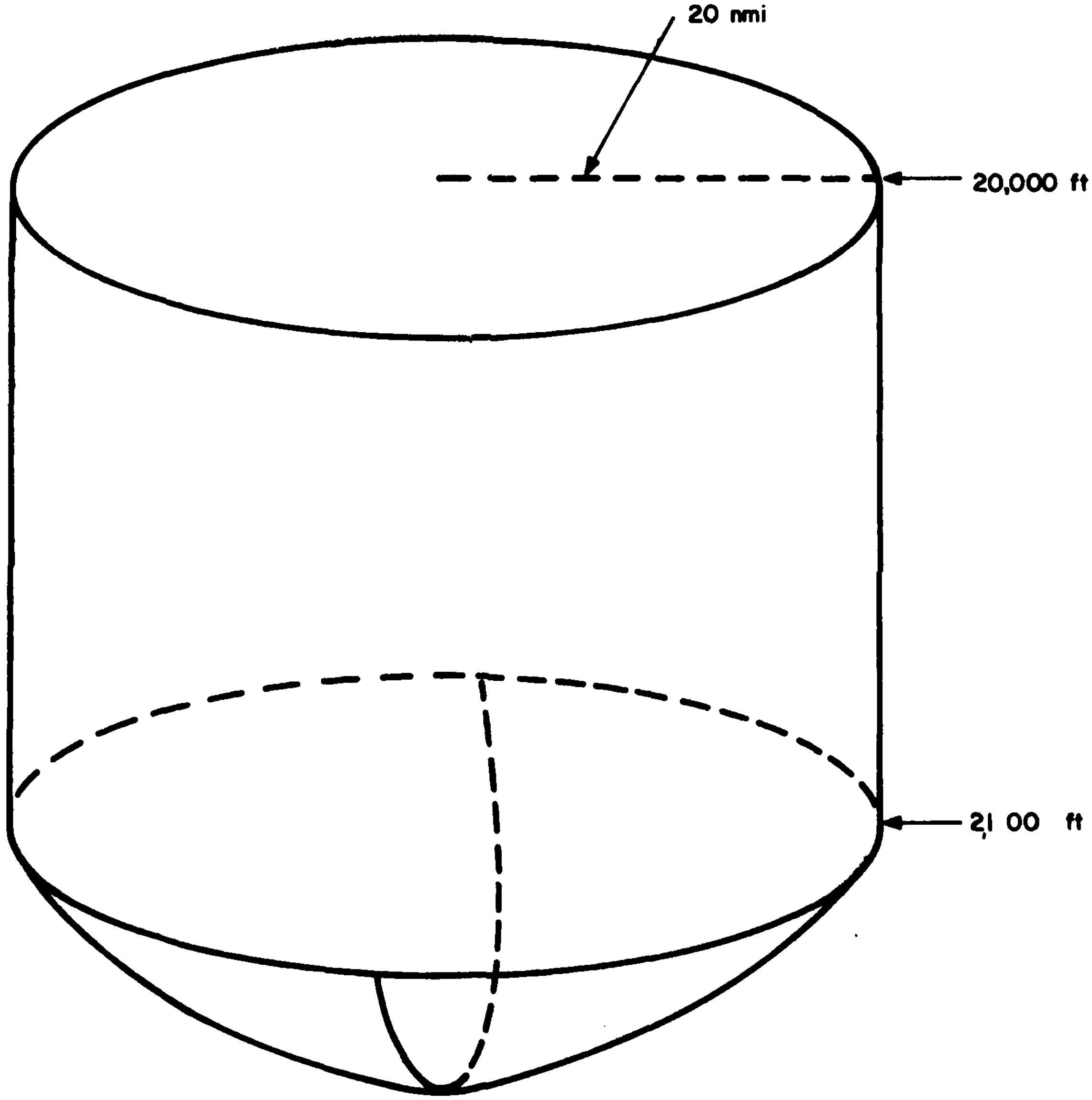


FIGURE B-15. PDME SERVICE COVERAGE.

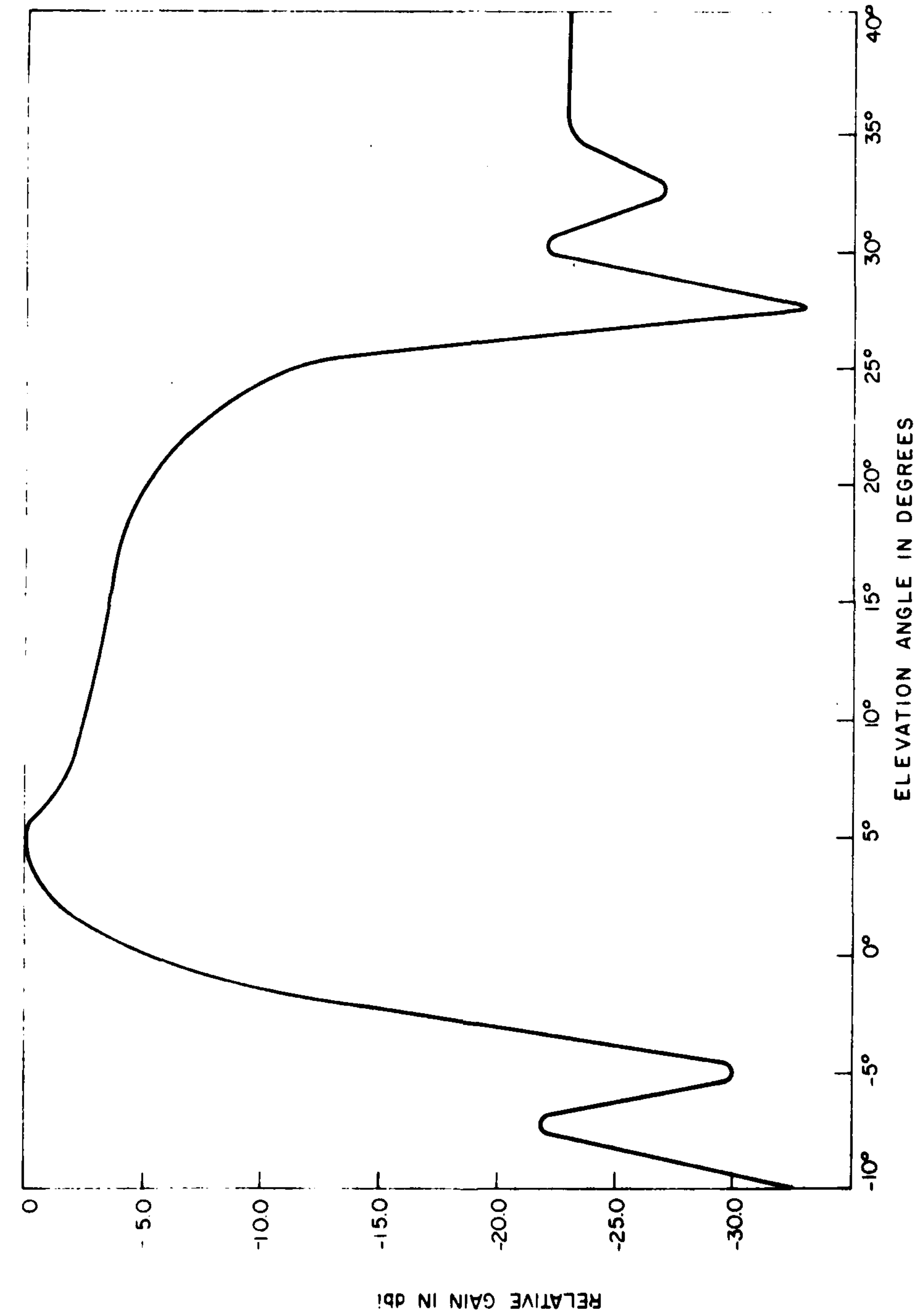


FIGURE B-16. PDME VERTICAL ANTENNA PATTERN.

APPENDIX C

EQUIPMENT PROTECTION CRITERIA

The MLS frequency-assignment model calculates the worst-case desired-to-undesired signal power ratio within the service volumes of each pair of equipments operating in the same band. It then determines the channel separation required for safe operation of each equipment pair based on the protection criteria input by the user. A different protection criterion is specified for each of the four bands to be assigned (C-band, L-band, VHF band and UHF band). In each case the criterion establishes the minimum D/U level allowed for the cochannel and adjacent-channel operation of equipments in these bands.

L-band contains three interacting types of equipments (DME, PDME, and TACAN). The operation of these equipments is such that D/U enhancement can be obtained by varying pulse-pair spacing, as well as by off-tuning. The L-band protection criteria reflects this added interference rejection by specifying D/U threshold levels for out-of-aperture (different pulse-pair spacing) interference as well as coaperture (like pulse-pair spacing) interference.

In C-band, MLS angle guidance is composed of many separate functions (elevation, azimuth, preamble, etc.) multiplexed onto a single frequency. In establishing a C-band protection criteria, it was necessary to determine which interaction of functions would cause the worst D/U degradation. It was found that for cochannel operation, the worst degradation was for a 3° azimuth scanning beam interfering with a 3° azimuth scanning beam. For adjacent-channel interactions, the worst degradation was for a preamble function interfering with a 3° azimuth scanning beam. This type of criterion requires that two worst-case D/U values be considered in the intersite analysis, scan beam-to-scan-beam for cochannel comparison and preamble-to-scan-beam for adjacent-channel comparison.

TABLES C-1 through C-4 list the protection criteria used in this particular trial assignment.

TABLE C-1

L-BAND PROTECTION CRITERIA[9]

Frequency and Pulse-Spacing Interaction	D/U Threshold (dB)
Cofrequency Coaperture	+ 8
Cofrequency Out-of-Aperture	+ 3
1st Adjacent Frequency Coaperture	-25
1st Adjacent Frequency Out-of-Aperture	-34
2nd Adjacent Frequency Coaperture	-34
2nd Adjacent Frequency Out-of-Aperture	-34

[9] Nanda, V. P., *Analystic Determination of Interference Thresholds for Microwave Landing System Equipment and TACAN/DME Equipment*, ECAC-PR-80-008, Annapolis, MD., to be published.

TABLE C-2

C-BAND PROTECTION CRITERIA[9]

	D/U Threshold
Cochannel	23.5 dB[a]
1st Adjacent Channel (±300 kHz)	-19.4 dB
2nd Adjacent Channel	-26.0 dB

[a]Recent tests at NAFFC have indicated that cochannel protection requires an absolute limit on the undesired signal of ≈ -103 dBm. The CAM will be revised to include this new type of protection criteria.

TABLE C-3

VHF BAND PROTECTION CRITERIA[10]

	D/U Threshold
Cochannel	20 dB
1st Adjacent Channel (±50 kHz)	- 7 dB
2nd Adjacent Channel (±100 kHz)	-46 dB
3rd Adjacent Channel (±150 kHz)	-50 dB

TABLE C-4

UHF BAND PROTECTION CRITERIA[10]

	D/U Threshold
Cochannel	20 dB
1st Adjacent Channel (±150 kHz)	0 dB
2nd Adjacent Channel (±300 kHz)	-20 dB
3rd Adjacent Channel (±450 kHz)	-40 dB
4th Adjacent Channel (±600 kHz)	-40 dB

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[9]Nanda, V. P., *Analytic Determination of Interference Thresholds for Microwave Landing System Equipment and TACAN/DME Equipment*, ECAC-PR-80-008, Annapolis, MD., to be published.

[10]Order 9840, Selection Order: U.S. National Aviation Standard for the VOR/DME/TACAN System, U.S. DOT/FAA undated.

APPENDIX D

TRIAL ENVIRONMENT

This appendix contains a listing of the airport and enroute environments used in the trial assignment. Listed along with each system is its present operating channel (if it is preassigned), and the channel assigned to it by the assignment model.

TABLE D-1 summarizes the number of individual equipments of each type included in the environments listed in TABLES D-2 and D-3.

TABLE D-1

TEST ENVIRONMENT SUMMARY

Facility	Existing Requirements	New Requirements[a]	Total
TACAN	118	0	118
DME	137	28	165
VOR	169	0	169
ILS	86	0	86
MLS Expanded	0	5	5
MLS Basic	0	136	136
MLS S. Com.	0	214	214
MLS PDME	0	66	66

[a]Note that frequency-pairing requirements within a particular channel plan may necessitate the protection of new "dummy" DME. VOR and ILS equipments whenever MLS equipments are assigned which do not require the physical installation of associated equipments. These dummy equipments are not included in the tables.

TABLE D-2

AIRPORT ENVIRONMENT
(Page 1 of 8)

SYSTEM ID#	LOCATION CITY/STATE	FAC CALL	AIRPORT TYPE	FAC LATITUDE	FAC LONGITUDE	RUN WAY	EXIST RNWY	MLS SERVICE	DME EQUIPMENT	ILS CPI	EQUIP CALL	LINK NUM	CHANNEL OLD/NEW
1	ANAHEIM /CA		NEW GENERAL	33 48 00 N	117 55 00 W	19	NO	SMALL COMNTY	MARKER BECN				/
2	ANAHEIM /CA		NEW GENERAL	33 48 00 N	117 55 00 W	14	NO	SMALL COMNTY	MARKER BECN				/
3	ANAHEIM /CA		NEW GENERAL	33 48 00 N	117 55 00 W	24	NO	SMALL COMNTY	MARKER BECN				/ 95Y
4	ANTIOCH /CA	O12	EXS GENERAL	37 58 05 N	121 48 00 W	9	NO	SMALL COMNTY	MARKER BECN				/ 18X
5	ANTIOCH /CA	O12	EXS GENERAL	37 58 05 N	121 48 00 W	3	NO	SMALL COMNTY	MARKER BECN				/ 41Y
6	APPLEVALLY/CA	APV	EXS AIR CARR	34 34 45 N	117 11 07 W	36	YES	SMALL COMNTY	ILS DME				/ 18Y
7	ARCATA /CA	ACV	EXS AIR CARR	40 59 00 N	124 06 00 W	31	YES	SMALL COMNTY	ILS DME	[illegible]	ACV		32X/ 32X
8	ARCATA /CA	ACV	EXS AIR CARR	40 59 00 N	124 06 00 W	1	YES	SMALL COMNTY	ILS DME				/ 24Y
9	AUBURN MUN/CA	AUN	EXS GENERAL	38 57 10 N	121 04 51 W	7	YES	SMALL COMNTY	ILS DME				/ 18Y
10	AVALON /CA	AVX	EXS GENERAL	33 24 20 N	118 24 50 W	22	YES	SMALL COMNTY	MARKER BECN				/ 23Y
11	AVALON /CA	AVX	EXS GENERAL	33 24 20 N	118 24 50 W	13	NO	SMALL COMNTY	MARKER BECN				/ 28Y
12	CATALINA /CA		NEW VSTOL	33 20 00 N	118 18 00 W	27	NO	SMALL COMNTY	MARKER BECN				/ 52Y
13	BAKERSFELD/CA	BFL	EXS AIR CARR	35 25 46 N	119 03 05 W	30R	YES	BASIC WIDE	P DME	R	BFL	1	36X/ 36X
14	BAKERSFELD/CA	BFL	EXS AIR CARR	35 25 46 N	119 03 05 W	12L	YES	BASIC WIDE	P DME	R	BFL	1	36X/ 36X
15	BISHOP /CA	BIH	EXS GENERAL	37 22 24 N	118 21 54 W	30	YES	SMALL COMNTY	MARKER BECN				/ 28Y
16	BLYTHE /CA	BLH	EXS GENERAL	33 37 15 N	114 43 08 W	26	YES	SMALL COMNTY	ILS DME	2	BLH		26X/ 26X
17	BREA /CA		NEW GENERAL	33 52 00 N	117 59 00 W	27	NO	SMALL COMNTY	ILS DME				/107Y
18	BREA /CA		NEW GENERAL	33 52 00 N	117 59 00 W	18	NO	SMALL COMNTY	MARKER BECN				/111Y
19	BURBANK /CA	BUR	EXS AIR CARR	34 12 00 N	118 21 28 W	8	YES	BASIC WIDE	P DME	2	BUR		32X/ 32X
20	BURBANK /CA	BUR	EXS AIR CARR	34 12 00 N	118 21 28 W	33	YES	BASIC WIDE	P DME				/ 27Z
21	CALEXICO /CA	CXL	EXS GENERAL	32 40 10 N	115 30 45 W	26	YES	SMALL COMNTY	MARKER BECN				/ 23Y
22	CARLSBAD /CA	CRQ	EXS GENERAL	33 07 41 N	117 16 46 W	24	YES	BASIC WIDE	P DME	2	CRQ		24X/ 24X
23	CHICO MUNI/CA	CIC	EXS AIR CARR	39 47 45 N	121 51 23 W	13L	YES	BASIC WIDE	P DME	3	CIC		50X/ 50X
24	CHINO /CA	CNO	EXS GENERAL	33 58 15 N	117 38 29 W	21	YES	BASIC WIDE	P DME				/ 29Z
25	CHINO /CA	CNO	EXS GENERAL	33 58 15 N	117 38 29 W	8	YES	SMALL COMNTY	MARKER BECN				/122Y
26	COALINGA /CA	CLG	EXS GENERAL	36 09 36 N	120 21 34 W	30	YES	SMALL COMNTY	MARKER BECN				/ 22Y
27	COLUMBIA /CA	O22	EXS GENERAL	38 01 45 N	120 24 45 W	17	YES	SMALL COMNTY	MARKER BECN				/ 85Y
28	COLUMBIA /CA	O22	EXS GENERAL	38 01 45 N	120 24 45 W	11	YES	SMALL COMNTY	MARKER BECN				/ 37Y
29	COLUSA CTY/CA	O09	EXS GENERAL	39 10 43 N	121 59 29 W	13	YES	SMALL COMNTY	MARKER BECN				/ 78Y
30	COMPTON /CA	CPM	EXS GENERAL	33 53 24 N	118 14 34 W	25L	YES	SMALL COMNTY	MARKER BECN				/ 80Y
31	CONCORD /CA	CCR	EXS GENERAL	37 59 23 N	122 03 21 W	19R	YES	BASIC WIDE	P DME	3	CCR		22X/ 22X
32	CORONA MUN/CA	L66	EXS GENERAL	33 53 55 N	117 36 05 W	25	YES	SMALL COMNTY	MARKER BECN				/ 31Y
33	CRESCENTCY/CA	CEC	EXS AIR CARR	41 46 49 N	124 14 07 W	11	YES	SMALL COMNTY	ILS DME	3	CEC		24X/ 24X
34	DAVIS /CA	O05	EXS GENERAL	38 31 55 N	121 47 10 W	16	YES	SMALL COMNTY	MARKER BECN				/ 35Y
35	EL MONTE /CA	EMT	EXS GENERAL	34 05 10 N	118 02 01 W	1	YES	BAS WIDE BAZ	P DME				/ 47Z
36	ELISNORE /CA		NEW GENERAL	33 38 00 N	117 18 00 W	11	NO	SMALL COMNTY	MARKER BECN				/ 21Y
37	ESCONDID /CA		NEW GENERAL	33 12 00 N	117 10 00 W	17	NO	SMALL COMNTY	MARKER BECN				/ 20Y
38	EUREKA /CA	EKA	EXS GENERAL	40 48 18 N	124 06 52 W	11	YES	SMALL COMNTY	MARKER BECN				/ 28X
39	EUREKA /CA	EKA	EXS GENERAL	40 48 18 N	124 06 52 W	7	YES	SMALL COMNTY	MARKER BECN				/ 18Y
40	FAIR OAKS /CA	O11	EXS GENERAL	38 39 26 N	121 13 04 W	18	YES	SMALL COMNTY	ILS DME				/ 83Y
41	FAIR OAKS /CA	O11	EXS GENERAL	38 39 26 N	121 13 04 W	36	YES	SMALL COMNTY	MARKER BECN				/ 86Y
42	FORTUNA /CA	FOT	EXS GENERAL	40 33 15 N	124 07 45 W	11	YES	SMALL COMNTY	MARKER BECN				/ 22Y
43	FRANKLIN /CA	Q53	EXS GENERAL	38 18 18 N	121 25 43 W	18	YES	SMALL COMNTY	MARKER BECN				/ 32Y
44	FREMONT /CA	Q59	EXS GENERAL	37 27 30 N	121 55 45 W	13R	YES	SMALL COMNTY	ILS DME				/ 29Y
45	FREMONT /CA	Q59	EXS GENERAL	37 27 30 N	121 55 45 W	5	NO	SMALL COMNTY	MARKER BECN				/ 42Y
46	FRESNO A T/CA	FAT	EXS AIR CARR	36 46 28 N	119 42 57 W	29R	YES	BASIC WIDE	P DME	R	FAT	2	40X/ 40X
47	FRESNO A T/CA	FAT	EXS AIR CARR	36 46 28 N	119 42 57 W	11L	YES	BASIC WIDE	P DME	R	FAT	2	40X/ 40X
48	FRESNO A T/CA	FAT	EXS AIR CARR	36 46 28 N	119 42 57 W	7	NO	BASIC WIDE	P DME				/ 17Z
49	FRESNO CHD/CA	FCH	EXS GENERAL	36 43 57 N	119 49 07 W	30L	YES	BASIC WIDE	P DME				/ 27Z
50	FRESNO CHD/CA	FCH	EXS GENERAL	36 43 57 N	119 49 07 W	30R	YES	SMALL COMNTY	ILS DME				/ 26Y

TABLE D-2

(Page 2 of 8)

SYSTEM ID#	LOCATION CITY/STATE	FAC CALL	AIRPORT TYPE	FAC LATITUDE	FAC LONGITUDE	RUN WAY	EXIST RNWY	MLS SERVICE	DME EQUIPMENT	ILS OPT	EQUIP CALL	LINK NUM	CHANNEL OLD/NEW
51	FRESNO CHD/CA	FCH	EXS GENERAL	36 43 57 N	119 49 07 W	21	NO	SMALL COMNTY	MARKER BECN				/ 20Y
52	FULLERTN /CA	FUL	EXS GENERAL	33 52 19 N	117 58 44 W	6	YES	BAS WIDE BAZ	P DME				/ 23Z
53	FULLERTN /CA	FUL	EXS GENERAL	33 52 19 N	117 58 44 W	24	YES	BAS WIDE BAZ	P DME				/ 35Z
54	GARBERVILL/CA	O16	EXS GENERAL	40 05 10 N	123 48 45 W	18	YES	SMALL COMNTY	MARKER BECN				/ 21Y
55	GRASS VLL /CA	O17	EXS GENERAL	39 13 25 N	121 00 15 W	7	YES	SMALL COMNTY	ILS DME				/ 38Y
56	GRASS VLL /CA	O17	EXS GENERAL	39 13 25 N	121 00 15 W	15	NO	SMALL COMNTY	MARKER BECN				/ 87Y
57	HALFMOONBY/CA	HAF	EXS GENERAL	37 30 50 N	122 30 00 W	30	YES	SMALL COMNTY	MARKER BECN				/ 28Y
58	HALFMOONBY/CA	HAF	EXS GENERAL	37 30 50 N	122 30 00 W	6	NO	SMALL COMNTY	MARKER BECN				/ 40Y
59	HANFORD MU/CA	O18	EXS GENERAL	36 19 04 N	119 37 39 W	14	YES	SMALL COMNTY	ILS DME				/ 24X
60	HANFORD MU/CA	O18	EXS GENERAL	36 19 04 N	119 37 39 W	6	NO	SMALL COMNTY	MARKER BECN				/ 18Y
61	HAWTHORN /CA	HHR	EXS GENERAL	33 55 23 N	118 20 03 W	25	YES	BASIC WIDE	P DME	2	HHR		44X/ 44X
62	HAWTHORN /CA	HHR	EXS GENERAL	33 55 23 N	118 20 03 W	7	YES	SMALL COMNTY	MARKER BECN				/
63	HAYWARD AT/CA	HWD	EXS GENERAL	37 39 34 N	122 07 18 W	10R	YES	BASIC WIDE	P DME				/ 39Z
64	HAYWARD AT/CA	HWD	EXS GENERAL	37 39 34 N	122 07 18 W	28L	YES	BASIC WIDE	P DME	3	HWD		52X/ 52X
65	HEMET RYAN/CA	HAT	EXS GENERAL	33 44 06 N	117 01 14 W	23	YES	SMALL COMNTY	MARKER BECN				/ 96Y
66	HOLLIST MU/CA	307	EXS GENERAL	36 53 25 N	121 24 30 W	12	YES	SMALL COMNTY	MARKER BECN				/ 54Y
67	HUNINGTON /CA	L16	EXS GENERAL	33 43 08 N	118 02 13 W	1	YES	SMALL COMNTY	MARKER BECN				/
68	IMPERIAL /CA	IPL	EXS AIR CARR	32 50 14 N	115 34 29 W	32	YES	SMALL COMNTY	MARKER BECN				/ 18Y
69	JACKSON /CA	O70	EXS GENERAL	38 22 45 N	120 48 00 W	17	YES	SMALL COMNTY	MARKER BECN				/ 21Y
70	KING CITY /CA	KIC	EXS GENERAL	36 13 41 N	121 07 15 W	11	YES	SMALL COMNTY	MARKER BECN				/ 27Y
71	LA HABRA /CA		NEW GENERAL	34 00 00 N	117 55 00 W	15	NO	SMALL COMNTY	MARKER BECN				/ 85Y
72	LA MESA /CA		NEW GENERAL	32 45 00 N	117 00 00 W	14	NO	SMALL COMNTY	MARKER BECN				/ 89Y
73	LAVERNE /CA	POC	EXS GENERAL	34 05 30 N	117 46 59 W	8	YES	BASIC WIDE	P DME				/ 39Z
74	LAVERNE /CA	POC	EXS GENERAL	34 05 30 N	117 46 59 W	26	YES	BASIC WIDE	P DME	3	POC		42X/ 42X
75	LANCASTER /CA	WJF	EXS GENERAL	34 44 26 N	118 13 04 W	24	YES	SMALL COMNTY	MARKER BECN				/ 46Y
76	LIVERMORE /CA	LVK	EXS GENERAL	37 41 41 N	121 49 02 W	7	YES	BAS WIDE BAZ	P DME				/ 21Z
77	LIVERMORE /CA	LVK	EXS GENERAL	37 41 41 N	121 49 02 W	25	YES	SMALL COMNTY	MARKER BECN				/ 82Y
78	LODI /CA	103	EXS GENERAL	38 12 11 N	121 16 03 W	8	YES	SMALL COMNTY	MARKER BECN				/ 36Y
79	LODI /CA	103	EXS GENERAL	38 12 11 N	121 16 03 W	12	YES	SMALL COMNTY	MARKER BECN				/ 46Y
80	LOMPOC /CA	LPC	EXS GENERAL	34 39 59 N	120 27 56 W	25	YES	SMALL COMNTY	MARKER BECN				/ 19Y
81	LONG BEACH/CA	LGB	EXS AIR CARR	33 49 03 N	118 09 24 W	30	YES	BASIC WIDE	P DME	2	LGB		40X/ 40X
82	LONG BEACH/CA	LGB	EXS AIR CARR	33 49 03 N	118 09 04 W	25R	YES	BAS WIDE BAZ	P DME				/ 31Z
83	LONG BEACH/CA	LGB	EXS AIR CARR	33 49 03 N	118 09 34 W	7L	YES	BAS WIDE BAZ	P DME				/ 51Z
84	VAN NUYS /CA	VNY	EXS AIR CARR	34 12 35 N	118 29 21 W	18	NO	SMALL COMNTY	MARKER BECN				/ 86Y
85	VAN NUYS /CA	VNY	EXS AIR CARR	34 12 35 N	118 29 21 W	9	NO	SMALL COMNTY	MARKER BECN				/ 90Y
86	VAN NUYS /CA	VNY	EXS AIR CARR	34 12 35 N	118 29 21 W	16R	YES	BASIC WIDE	P DME	2	VNY		50X/ 50X
87	VAN NUYS /CA	VNY	EXS AIR CARR	34 12 35 N	118 29 21 W	34L	YES	BASIC WIDE	P DME				/ 72Z
88	LOS ANGLES/CA	LAX	EXS VSTOL	33 56 32 N	118 24 26 W	27	NO	SMALL COMNTY	MARKER BECN				/ 97Y
89	LOS ANGLES/CA		NEW VSTOL	34 03 00 N	118 15 00 W	27	NO	SMALL COMNTY	MARKER BECN				/
90	LOS ANGLES/CA	WHP	EXS GENERAL	34 15 35 N	118 24 45 W	12	YES	SMALL COMNTY	MARKER BECN				/ 38Y
91	LOS ANGLES/CA	LAX	EXS AIR CARR	33 56 32 N	118 24 26 W	25L	YES	BASIC WIDE	P DME	2	LAX	3	36X/
92	LOS ANGLES/CA	LAX	EXS AIR CARR	33 56 32 N	118 24 26 W	25L	YES	BAS WIDE BAZ	P DME	2	IAS	4	48X/
93	LOS ANGLES/CA	LAX	EXS AIR CARR	33 56 32 N	118 24 26 W	25R	YES	EXPANDED	P DME	2	CFN	3	36X/
94	LOS ANGLES/CA	LAX	EXS AIR CARR	33 56 32 N	118 24 26 W	7R	YES	EXPANDED BAZ	P DME	2	MKZ	4	48X/
95	LOS ANGLES/CA	LAX	EXS AIR CARR	33 56 32 N	118 24 26 W	25L	YES	BAS WIDE BAZ	P DME	2	HOB	5	22X/ 22X
96	LOS ANGLES/CA	LAX	EXS AIR CARR	33 56 32 N	118 24 26 W	25R	YES	BASIC WIDE	P DME	2	OSS	5	22X/ 22X
97	LOS ANGLES/CA	LAX	EXS AIR CARR	33 56 32 N	118 24 26 W	25R	YES	BASIC WIDE	P DME	2	GPE	6	54X/ 54X
98	LOS ANGLES/CA	LAX	EXS AIR CARR	33 56 32 N	118 24 26 W	7L	YES	BASIC WIDE	P DME	2	UWU	6	54X/ 54X
99	LOS BANOS /CA	LSN	EXS GENERAL	37 03 43 N	120 52 05 W	14	YES	SMALL COMNTY	MARKER BECN				/ 80Y
100	PEARCE FLD/CA	209	EXS GENERAL	38 56 05 N	122 37 20 W	12	YES	SMALL COMNTY	MARKER BECN				/ 44Y

TABLE D-2

(Page 3 of 8)

SYSTEM ID#	LOCATION CITY/STATE	FAC CALL	AIRPORT TYPE	FAC LATITUDE	FAC LONGITUDE	RUN WAY	EXIST RNWY	MLS SERVICE	DME EQUIPMENT	ILS OPT	EQUIP CALL	LINK NUM	CHANNEL OLD/NEW
101	MADERA MUN/CA	MAE	EXS GENERAL	36 59 15 N	120 06 40 W	30	YES	SMALL COMNTY	MARKER BECN				/ 23Y
102	MALIBU /CA		NEW GENERAL	34 02 00 N	118 41 00 W	25	NO	SMALL COMNTY	MARKER BECN				/ 25Y
103	MAMMOTH LK/CA	MMH	EXS GENERAL	37 37 40 N	118 50 55 W	9	YES	SMALL COMNTY	MARKER BECN				/ 19Y
104	MERCED MUN/CA	MCE	EXS AIR CARR	37 17 06 N	120 30 34 W	30	YES	SMALL COMNTY	MARKER BECN	R	MCE	7	30X/ 30X
105	MERCED MUN/CA	MCE	EXS AIR CARR	37 17 06 N	120 30 34 W	12	YES	SMALL COMNTY	MARKER BECN	R	MCE	7	30X/ 30X
106	MARYSVILLE/CA	MYV	EXS AIR CARR	39 05 53 N	121 34 06 W	14	YES	BASIC WIDE	P DME				/ 23Z
107	MODESTO CY/CA	MOD	EXS AIR CARR	37 37 36 N	120 57 18 W	28R	YES	BASIC WIDE	P DME	2	MOD		56X/ 56X
108	MOJAVE /CA	MHV	EXS GENERAL	35 04 00 N	118 09 00 W	14	YES	SMALL COMNTY	MARKER BECN				/ 24Y
109	MONROVIA /CA		NEW GENERAL	34 08 00 N	117 56 00 W	30	NO	SMALL COMNTY	ILS DME				/ 18X
110	MONROVIA /CA		NEW GENERAL	34 08 00 N	117 56 00 W	12	NO	SMALL COMNTY	ILS DME				/102Y
111	MONTAGUE /CA	SIY	EXS GENERAL	41 46 54 N	122 28 31 W	35	YES	SMALL COMNTY	MARKER BECN				/ 20X
112	MONTEBELLO/CA		NEW GENERAL	34 00 00 N	118 06 00 W	30	NO	SMALL COMNTY	MARKER BECN				/ 29Y
113	MONTEBELLO/CA		NEW GENERAL	34 00 00 N	118 06 00 W	12	NO	SMALL COMNTY	MARKER BECN				/ 26Y
114	MONTEREY P/CA	MRY	EXS AIR CARR	36 35 17 N	121 50 23 W	10	YES	BASIC WIDE	P DME	2	MRY		38X/ 38X
115	MONTEREY P/CA	MRY	EXS AIR CARR	36 35 17 N	121 50 53 W	6	YES	BASIC WIDE	P DME				/ 25Z
116	MOOR PARK /CA		NEW GENERAL	34 15 00 N	119 05 00 W	25	NO	SMALL COMNTY	ILS DME				/
117	MOOR PARK /CA		NEW GENERAL	34 15 00 N	118 05 00 W	7	NO	SMALL COMNTY	MARKER BECN				/
118	NAPA CNTY /CA	APC	EXS GENERAL	38 12 48 N	122 16 47 W	18R	YES	BAS WIDE BAZ	P DME				/ 31Z
119	NAPA CNTY /CA	APC	EXS GENERAL	38 12 48 N	122 16 47 W	36L	YES	BAS WIDE BAZ	P DME				/ 37Z
120	NEWHALL /CA		NEW GENERAL	34 23 00 N	118 30 00 W	12	NO	SMALL COMNTY	MARKER BECN				/ 34Y
121	NOVATO /CA	O56	EXS GENERAL	38 08 40 N	122 33 25 W	13	YES	SMALL COMNTY	MARKER BECN				/ 27Y
122	OAKDALE /CA	O27	EXS GENERAL	37 45 23 N	120 48 01 W	10	YES	SMALL COMNTY	MARKER BECN				/ 22Y
123	OAKLAND /CA	OAK	EXS AIR CARR	37 43 19 N	122 13 10 W	28R	YES	360 EXPN BAZ	P DME	2	OAK		36X/ 36X
124	OAKLAND /CA	OAK	EXS AIR CARR	37 43 19 N	122 13 10 W	10L	YES	BASIC WIDE	P DME				/ 29Z
125	OAKLAND /CA	OAK	EXS AIR CARR	37 43 19 N	122 13 10 W	29	YES	BASIC WIDE	P DME	2	INR		24X/
126	OAKLAND /CA	OAK	EXS AIR CARR	37 43 19 N	122 13 13 W	11	YES	BASIC WIDE	P DME	3	AAZ		56X/
127	OCEANO CNY/CA	L52	EXS GENERAL	35 06 00 N	120 37 45 W	29	YES	SMALL COMNTY	MARKER BECN				/ 21Y
128	OCEANSIDE /CA	OCN	EXS GENERAL	33 13 02 N	117 21 10 W	24	YES	SMALL COMNTY	MARKER BECN				/ 44Y
129	ONTARIO /CA	ONT	EXS AIR CARR	34 03 26 N	117 36 29 W	26	YES	BAS WIDE BAZ	P DME	2	ONT	8	34X/ 34X
130	ONTARIO /CA	ONT	EXS AIR CARR	34 03 26 N	117 36 29 W	8	YES	BAS WIDE BAZ	P DME	3	CAD	8	34Y/ 34X
131	OROVILLE /CA	OVE	EXS GENERAL	39 29 30 N	121 37 05 W	12	YES	SMALL COMNTY	MARKER BECN				/ 88Y
132	OROVILLE /CA	OVE	EXS GENERAL	39 29 30 N	121 37 05 W	1	YES	SMALL COMNTY	MARKER BECN				/ 40Y
133	OXNARD /CA	OXR	EXS AIR CARR	34 12 04 N	119 12 23 W	25	YES	BASIC WIDE	P DME	2	OXR		24Y/
134	PALM SPRG /CA	PSP	EXS AIR CARR	33 49 36 N	116 30 18 W	30	YES	BAS WIDE BAZ	P DME				/ 27Z
135	PALM SPRG /CA	PSP	EXS AIR CARR	33 49 36 N	116 30 18 W	6	YES	BASIC WIDE	P DME				/ 21Z
136	PALO ALTO /CA	PAO	EXS GENERAL	37 27 40 N	122 06 59 W	12	YES	BAS WIDE BAZ	P DME				/ 37Z
137	PASO ROBLE/CA	PRB	EXS AIR CARR	35 40 11 N	120 37 34 W	19	YES	BASIC WIDE	P DME				/ 28Z
138	PETALUMA /CA	O69	EXS GENERAL	38 15 30 N	122 36 45 W	29	YES	SMALL COMNTY	ILS DME				/ 39Y
139	PETALUMA /CA	O69	EXS GENERAL	38 15 30 N	122 36 45 W	24	NO	SMALL COMNTY	MARKER BECN				/ 48Y
140	PLACERVILL/CA	PVP	EXS GENERAL	38 43 26 N	120 45 12 W	23	YES	SMALL COMNTY	MARKER BECN				/ 34Y
141	PORTERVILL/CA	PVT	EXS GENERAL	36 01 40 N	119 03 45 W	30	YES	SMALL COMNTY	MARKER BECN				/ 39Y
142	PORTERVILL/CA	PVT	EXS GENERAL	36 01 40 N	119 03 45 W	25	NO	SMALL COMNTY	MARKER BECN				/ 43Y
143	QUINCY /CA	L39	EXS GENERAL	33 02 15 N	116 54 30 W	27	YES	SMALL COMNTY	MARKER BECN				/ 52X
144	RED BLUFF /CA	RBL	EXS GENERAL	40 09 08 N	122 14 59 W	7	YES	SMALL COMNTY	MARKER BECN				/ 18X
145	RED BLUFF /CA	RBL	EXS GENERAL	40 09 08 N	122 14 59 W	15	YES	SMALL COMNTY	MARKER BECN				/ 29Y
146	REDDING /CA	RDD	EXS GENERAL	40 30 29 N	122 17 32 W	12	YES	SMALL COMNTY	ILS DME				/ 26Y
147	REDDING /CA	RDD	EXS GENERAL	40 30 29 N	122 17 32 W	34	YES	SMALL COMNTY	ILS DME	R	RDD	26	24X/
148	REDDING /CA	RDD	EXS GENERAL	40 30 29 N	122 17 32 W	16	YES	SMALL COMNTY	ILS DME	R	RDD	26	24X/
149	REDLANDS /CA	L12	EXS GENERAL	34 05 00 N	117 08 00 W	26	YES	SMALL COMNTY	MARKER BECN				/ 19Y
150	REDLANDS /CA	L12	EXS GENERAL	34 05 00 N	117 08 00 W	14	NO	SMALL COMNTY	MARKER BECN				/ 43Y

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SYSTEM ID#	LOCATION CITY/STATE	FAC CALL	AIRPORT TYPE	FAC LATITUDE	FAC LONGITUDE	RUN WAY	EXIST RNWY	MLS SERVICE	DME EQUIPMENT	ILS OPT	EQUIP CALL	LINK NUM	CHANNEL OLD/NEW
151	RICHMOND /CA		NEW GENERAL	37 55 00 N	122 20 00 W	29	NO	SMALL COMNTY	MARKER BECN				/ 43Y
152	RIALTO /CA	L67	EXS GENERAL	34 07 45 N	117 23 30 W	24	YES	SMALL COMNTY	MARKER BECN				/ 87Y
153	RIVERSIDE /CA	RAL	EXS AIR CARR	33 57 06 N	117 26 32 W	9R	YES	BAS WIDE BAZ	P DME	3	RAL		46X/ 46X
154	RIVERSIDE /CA	RAL	EXS AIR CARR	33 57 06 N	117 26 32 W	34	YES	SMALL COMNTY	MARKER BECN				/ 48Y
155	SACRAMENTO/CA	SMF	EXS AIR CARR	38 41 44 N	121 36 01 W	16L	YES	BAS WIDE BAZ	P DME	2	SMF		20X/ 20X
156	SACRAMENTO/CA	SMF	EXS AIR CARR	38 41 44 N	121 36 01 W	34R	YES	BAS WIDE BAZ	P DME	3	HUX		48X/ 48X
157	SACRAMENTO/CA	SMF	EXS AIR CARR	38 41 44 N	121 36 01 W	6	NO	SMALL COMNTY	MARKER BECN				/ 56Y
158	SACRAMENTO/CA	SAC	EXS GENERAL	38 30 47 N	121 29 32 W	2	YES	BAS WIDE BAZ	P DME	R	SAC	10	40X/
159	SACRAMENTO/CA	SAC	EXS GENERAL	38 30 47 N	121 29 32 W	20	YES	BAS WIDE BAZ	P DME	R	SAC	10	40Y/
160	SALINAS /CA	SNS	EXS GENERAL	36 39 45 N	121 36 20 W	31	YES	BAS WIDE BAZ	P DME	3	SNS		22X/
161	SALINAS /CA	SNS	EXS GENERAL	36 39 45 N	121 36 20 W	8	YES	SMALL COMNTY	MARKER BECN				/ 50X
162	SANBERNADI/CA	SBT	EXS GENERAL	34 04 03 N	117 16 26 W	25	YES	SMALL COMNTY	MARKER BECN				/ 54Y
163	SANBERNADI/CA	SBT	EXS GENERAL	34 04 03 N	117 16 26 W	34	YES	SMALL COMNTY	MARKER BECN				/ 84Y
164	SAN CARLOS/CA	SQL	EXS GENERAL	37 30 40 N	122 14 55 W	12	YES	BASIC WIDE	P DME				/ 20Z
165	INYOKERN /CA	IYK	EXS AIR CARR	35 39 32 N	117 49 43 W	2	YES	SMALL COMNTY	MARKER BECN				/ 26X
166	SAN DIEGO /CA	SAN	EXS AIR CARR	32 44 01 N	117 11 12 W	27	YES	BAS WIDE BAZ	P DME	R	SAN	11	46X/
167	SAN DIEGO /CA	SAN	EXS AIR CARR	32 44 01 N	117 11 12 W	27	YES	BAS WIDE BAZ	P DME	R	SAN	11	46X/
168	SAN DIEGO /CA	SAN	EXS AIR CARR	32 44 01 N	117 11 12 W	13	YES	BASIC WIDE	ILS DME				/ 81Y
169	SAN DIEGO /CA	SDM	EXS GENERAL	32 34 20 N	116 58 47 W	8L	YES	SMALL COMNTY	ILS DME				/ 22Y
170	SAN DIEGO /CA	SDM	EXS GENERAL	32 34 20 N	116 58 47 W	26R	YES	SMALL COMNTY	MARKER BECN				/ 39Y
171	SAN DIEGO /CA		NEW AIR CARR	33 00 00 N	117 00 00 W	25	NO	SMALL COMNTY	ILS DME				/ 30Y
172	SAN DIEGO /CA		NEW AIR CARR	33 00 00 N	117 00 00 W	7	NO	SMALL COMNTY	ILS DME				/ 37Y
173	SAN DIEGO /CA	SEE	EXS GENERAL	32 49 33 N	116 58 19 W	27R	YES	BAS WIDE BAZ	P DME	1	SEE	12	42X/ 42X
174	SAN DIEGO /CA	SEE	EXS GENERAL	32 49 33 N	116 58 19 W	9L	YES	BAS WIDE BAZ	P DME	1	SEE	12	42X/ 42X
175	SAN DIEGO /CA	MYF	EXS GENERAL	32 48 58 N	117 08 24 W	10L	YES	BAS WIDE BAZ	P DME	3	MYF		54X/
176	SAN DIEGO /CA	MYF	EXS GENERAL	32 48 58 N	117 08 24 W	28R	YES	BAS WIDE BAZ	P DME				/ 19Z
177	SAN FERNAD/CA	SFF	EXS GENERAL	34 17 25 N	118 25 15 W	19	YES	SMALL COMNTY	MARKER BECN				/112Y
178	SANFRN /CA		NEW VSTOL	37 37 00 N	122 23 00 W	27	NO	SMALL COMNTY	MARKER BECN				/ 19Y
179	SAN FRANCI/CA	SFO	EXS AIR CARR	37 37 10 N	122 22 28 W	28R	YES	360 EXPN BAZ	P DME	2	GWG		54X/
180	SAN FRANCI/CA	SFO	EXS AIR CARR	37 37 10 N	122 22 28 W	28L	YES	BAS WIDE BAZ	P DME	3	SFO		32X/ 32X
181	SAN FRANCI/CA	SFO	EXS AIR CARR	37 37 18 N	122 22 23 W	19L	YES	BASIC WIDE	P DME	2	SIA		26X/ 26X
182	SAN FRANCI/CA		NEW GENERAL	37 40 00 N	122 25 00 W	28	NO	BASIC WIDE	P DME				/ 44Z
183	SAN JOSE /CA		NEW GENERAL	37 20 00 N	121 50 00 W	30	NO	BASIC WIDE	P DME				/ 35Z
184	SAN JOSE /CA	RHV	EXS GENERAL	37 19 59 N	121 49 07 W	31R	YES	BASIC WIDE	P DME				/ 40Z
185	SAN JOSE /CA	SJC	EXS AIR CARR	37 21 41 N	121 55 38 W	12R	YES	BASIC WIDE	P DME	3	SVL		4EX/
186	SAN JOSE /CA	SJC	EXS AIR CARR	37 21 41 N	121 55 38 W	30L	YES	BASIC WIDE	P DME	2	SJC		46X/ 46X
187	SAN JUAN /CA		NEW GENERAL	33 33 00 N	117 40 00 W	2	NO	SMALL COMNTY	MARKER BECN				/ 27Y
188	SAN JUAN /CA		NEW GENERAL	33 33 00 N	117 40 00 W	13	NO	SMALL COMNTY	MARKER BECN				/ 35Y
189	SAN LUIS /CA	SBP	EXS GENERAL	35 14 11 N	120 38 26 W	11	YES	SMALL COMNTY	ILS DME	3	SBP		14X/
190	SAN MARTIN/CA	Q99	EXS AIR CARR	37 04 55 N	121 35 45 W	27	NO	SMALL COMNTY	MARKER BECN				/ 24Y
191	SAN MARTIN/CA	Q99	EXS AIR CARR	37 04 55 N	121 35 45 W	14	YES	SMALL COMNTY	MARKER BECN				/ 38Y
192	SAN PEDRO /CA		NEW GENERAL	33 45 00 N	118 16 00 W	30	NO	SMALL COMNTY	MARKER BECN				/
193	SAN SIMON /CA		NEW GENERAL	35 39 00 N	112 12 00 W	30	NO	SMALL COMNTY	MARKER BECN				/ 23Y
194	SANTA ANA /CA	SNA	EXS AIR CARR	33 40 32 N	117 52 01 W	19R	YES	BAS WIDE BAZ	P DME	R	SNA	13	20X/ 20X
195	SANTA ANA /CA	SNA	EXS AIR CARR	33 40 32 N	117 52 01 W	1L	YES	BAS WIDE BAZ	P DME	R	SNA	13	20X/ 20X
196	SANTA ANA /CA	SNA	EXS AIR CARR	33 40 32 N	117 52 01 W	13	NO	SMALL COMNTY	MARKER BECN				/
197	SANTA ANA /CA		NEW GENERAL	33 45 00 N	117 51 00 W	19	NO	SMALL COMNTY	ILS DME				/
198	SANTA ANA /CA		NEW GENERAL	33 45 00 N	117 51 00 W	10	NO	SMALL COMNTY	MARKER BECN				/
199	SANTA BARB/CA	SBA	EXS AIR CARR	34 25 39 N	119 50 17 W	7	YES	BASIC WIDE	P DME	2	SBA		40X/
200	SANTA BARB/CA	SBA	EXS AIR CARR	34 25 39 N	119 50 17 W	15R	YES	SMALL COMNTY	MARKER BECN				/ 22Y

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SYSTEM ID#	LOCATION CITY/STATE	FAC CALL	AIRPORT TYPE	FAC LATITUDE	FAC LONGITUDE	RUN WAY	EXIST RNWY.	MLS SERVICE	DME EQUIPMENT	ILS OPT	EQUIP CALL	LINK NUM	CHANNEL OLD/NEW
201	SANTA CRUZ/CA	SRV	EXS GENERAL	37 03 03 N	122 01 50 W	13	YES	SMALL COMNTY	MARKER BECN				/ 33Y
202	SANTA MARI/CA	SMX	EXS AIR CARR	39 53 56 N	120 27 23 W	12	YES	BAS WIDE BAZ	P DME	R	SMX	14	26X/
203	SANTA MARI/CA	SMX	EXS AIR CARR	39 53 56 N	120 27 23 W	30	YES	BAS WIDE BAZ	P DME	R	SMX	14	26X/
204	SANTA MARI/CA	SMX	EXS AIR CARR	39 53 56 N	120 27 23 W	20	YES	SMALL COMNTY	MARKER BECN				/ 30Y
205	SANTA MONI/CA	SMO	EXS GENERAL	34 00 58 N	118 27 03 W	3	YES	BAS WIDE BAZ	P DME				/ 17Z
206	SANTA MONI/CA	SMO	EXS GENERAL	34 00 58 N	118 27 03 W	21	YES	BAS WIDE BAZ	P DME				/ 57Z
207	SANTAPAULA/CA	SZP	EXS GENERAL	34 20 50 N	119 03 37 W	22	YES	SMALL COMNTY	MARKER BECN				/ 30Y
208	SANTA ROSA/CA	STS	EXS AIR CARR	38 30 32 N	122 48 42 W	32	YES	BASIC WIDE	P DME	3	STS		30X/
209	SANTA ROSA/CA	O01	EXS GENERAL	38 24 52 N	122 45 25 W	16	YES	SMALL COMNTY	ILS DME				/ 42X
210	SANTA ROSA/CA	O01	EXS GENERAL	38 24 52 N	122 45 25 W	34	YES	SMALL COMNTY	MARKER BECN				/ 23Y
211	SIMI VALLY/CA	L02	EXS GENERAL	34 16 10 N	118 42 15 W	7	YES	SMALL COMNTY	MARKER BECN				/ 42Y
212	SIMI VALLY/CA	L02	EXS GENERAL	34 16 10 N	118 42 15 W	14	NO	SMALL COMNTY	MARKER BECN				/
213	SANTA YNEZ/CA	L47	EXS GENERAL	34 36 27 N	120 04 28 W	8	YES	SMALL COMNTY	ILS DME				/ 35Y
214	SANTA YNEZ/CA	L47	EXS GENERAL	34 36 27 N	120 04 28 W	17	NO	SMALL COMNTY	MARKER BECN				/ 31Y
215	SCHELLVILL/CA	O03	EXS GENERAL	38 13 25 N	122 26 55 W	16	YES	SMALL COMNTY	MARKER BECN				/ 20Y
216	SLAKETAHOE/CA	TVL	EXS AIR CARR	38 53 39 N	119 59 42 W	18	YES	SMALL COMNTY	ILS DME	3	TVL		26X/
217	SLAKETAHOE/CA	TVL	EXS AIR CARR	38 53 39 N	119 59 42 W	6	NO	SMALL COMNTY	MARKER BECN				/ 31Y
218	STOCKTON /CA	SCK	EXS GENERAL	37 53 39 N	121 14 14 W	29R	YES	BASIC WIDE	P DME	1	SCK	27	28X/ 28X
219	STOCKTON /CA	SCK	EXS GENERAL	37 53 39 N	121 14 14 W	11L	YES	BASIC WIDE	P DME	R	SCK	27	28X/ 28X
220	STOCKTON /CA	SCK	EXS GENERAL	37 53 39 N	121 14 14 W	20	NO	SMALL COMNTY	MARKER BECN				/ 50Y
221	SUSANVILLE/CA	SVE	EXS AIR CARR	40 22 45 N	120 54 25 W	11	YES	SMALL COMNTY	MARKER BECN				/ 19Y
222	THERMAL /CA	TRM	EXS GENERAL	33 37 36 N	116 09 39 W	17	YES	SMALL COMNTY	MARKER BECN	R	TRM	15	32X/
223	THERMAL /CA	TRM	EXS GENERAL	33 37 36 N	116 09 39 W	35	YES	SMALL COMNTY	MARKER BECN	R	TRM	15	32X/
224	TORRANCE /CA	TOA	EXS GENERAL	33 48 12 N	118 20 19 W	29R	YES	BASIC WIDE	P DME	2	TCA		56X/
225	TRACY /CA	O35	EXS GENERAL	37 41 15 N	121 26 25 W	29	YES	SMALL COMNTY	MARKER BECN				/ 25Y
226	TUCKEE /CA	TRK	EXS GENERAL	39 19 15 N	120 08 20 W	28	YES	SMALL COMNTY	MARKER BECN				/ 28Y
227	TULARE /CA	1O7	EXS GENERAL	36 15 35 N	119 18 19 W	17	YES	SMALL COMNTY	MARKER BECN				/ 33Y
228	TURLOCK /CA	O15	EXS GENERAL	37 29 15 N	120 41 45 W	30	YES	SMALL COMNTY	MARKER BECN				/ 45Y
229	TUSTIN /CA		NEW GENERAL	33 45 00 N	117 45 00 W	27	NO	SMALL COMNTY	ILS DME				/
230	TUSTIN /CA		NEW GENERAL	33 45 00 N	117 45 00 W	9	NO	SMALL COMNTY	MARKER BECN				/
231	UKIAH /CA	UKI	EXS GENERAL	39 07 37 N	123 12 00 W	15	YES	SMALL COMNTY	ILS DME	3	UKI		28X/
232	UKIAH /CA	UKI	EXS GENERAL	39 07 37 N	123 12 00 W	5	NO	SMALL COMNTY	MARKER BECN				/ 45Y
233	UPLAND /CA	CCB	EXS GENERAL	34 07 00 N	117 41 45 W	24	YES	SMALL COMNTY	MARKER BECN				/
234	VACAVILLE /CA	O45	EXS GENERAL	38 22 33 N	121 57 43 W	1	YES	SMALL COMNTY	MARKER BECN				/ 26Y
235	VISALIA /CA	VIS	EXS AIR CARR	36 19 11 N	119 23 34 W	30	YES	SMALL COMNTY	MARKER BECN	1	VIS	16	22X/
236	VISALIA /CA	VIS	EXS AIR CARR	36 19 11 N	119 23 34 W	12	YES	SMALL COMNTY	MARKER BECN	1	VIS	16	22X/
237	WATSONVILL/CA	WVI	EXS GENERAL	36 56 12 N	121 47 24 W	1	YES	SMALL COMNTY	ILS DME	1	AYN	17	20X/
238	WATSONVILL/CA	WVI	EXS GENERAL	36 56 12 N	121 47 24 W	19	YES	SMALL COMNTY	ILS DME	R		17	20X/
239	WATSONVILL/CA	WVI	EXS GENERAL	36 56 12 N	121 47 24 W	8	YES	SMALL COMNTY	MARKER BECN				/ 44Y
240	W COVINA /CA		NEW VSTOL	34 03 00 N	118 00 00 W	27	NO	SMALL COMNTY	MARKER BECN				/ 88Y
241	WHITTIER /CA		NEW GENERAL	35 56 00 N	118 03 00 W	14	NO	SMALL COMNTY	MARKER BECN				/ 21Y
242	WILLITS /CA	WLW	EXS GENERAL	39 31 00 N	122 12 59 W	34	YES	SMALL COMNTY	MARKER BECN				/ 91Y
243	WOODLAND /CA	O41	EXS GENERAL	38 40 30 N	121 52 15 W	18	YES	SMALL COMNTY	ILS DME				/ 52Y
244	WOODLAND /CA	O41	EXS GENERAL	38 40 30 N	121 52 15 W	7	NO	SMALL COMNTY	MARKER BECN				/ 79Y
245	YUBA CITY /CA	O52	EXS GENERAL	39 07 36 N	121 36 29 W	17	YES	SMALL COMNTY	ILS DME				/ 54Y
246	YUBA CITY /CA	O52	EXS GENERAL	39 07 36 N	121 36 29 W	9	NO	SMALL COMNTY	MARKER BECN				/ 84Y
247	YUCCA VALL/CA	L22	EXS GENERAL	34 07 40 N	116 24 25 W	6	YES	SMALL COMNTY	MARKER BECN				/ 33Y
248	BOULDER /NV	BLD	EXS GENERAL	35 57 50 N	114 51 05 W	3	YES	SMALL COMNTY	MARKER BECN				/ 23Y
249	CARSON CTY/NV	O04	EXS GENERAL	39 11 30 N	119 44 05 W	27	YES	SMALL COMNTY	MARKER BECN				/ 23Y
250	ELKO /NV	EKO	EXS AIR CARR	40 49 25 N	115 47 22 W	5	YES	SMALL COMNTY	MARKER BECN				/ 18Y

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SYSTEM ID#	LOCATION CITY/STATE	FAC CALL	AIRPORT TYPE	FAC LATITUDE	FAC LONGITUDE	RUN WAY	EXIST RNWY	MLS SERVICE	DME EQUIPMENT	ILS OPT	EQUIP CALL	LINK NUM	CHANNEL OLD/NEW
251	ELY /NV	ELY	EXS AIR CARR	39 18 07 N	114 50 31 W	19	YES	SMALL COMNTY	MARKER BECN				/ 18X
252	HAWTHORNE /NV	HTH	EXS GENERAL	38 32 40 N	118 38 00 W	10	YES	SMALL COMNTY	MARKER BECN				/ 24Y
253	LAS VEGAS /NV	VGT	EXS GENERAL	36 12 45 N	115 11 46 W	7	YES	SMALL COMNTY	MARKER BECN				/ 18Y
254	LAS VEGAS /NV	VGT	EXS GENERAL	36 12 45 N	115 11 46 W	12	YES	SMALL COMNTY	ILS DME				/ 22X
255	LAS VEGAS /NV	LAS	EXS AIR CARR	36 04 48 N	115 09 09 W	19L	YES	BAS WIDE BAZ	P DME				/ 25Z
256	LAS VEGAS /NV	LAS	EXS AIR CARR	36 04 48 N	115 09 09 W	1R	YES	BAS WIDE BAZ	P DME				/ 19Z
257	LAS VEGAS /NV	LAS	EXS AIR CARR	36 04 48 N	115 09 09 W	25	YES	BASIC WIDE	P DME	2	LAS		32X/ 32X
258	RENO /NV	RNO	EXS AIR CARR	39 29 52 N	119 46 03 W	16	YES	BAS WIDE BAZ	P DME	8	RNO	18	52X/
259	RENO /NV	RNO	EXS AIR CARR	39 29 52 N	119 46 03 W	34	YES	BAS WIDE BAZ	P DME	6	RNO	18	52X/
260	RENO /NV	RNO	EXS AIR CARR	39 29 52 N	119 46 03 W	7	YES	BASIC WIDE	P DME				/ 24Z
261	RENO /NV	4SD	EXS GENERAL	39 40 28 N	119 52 36 W	32	YES	SMALL COMNTY	MARKER BECN				/ 20Y
262	BRIGHAM /UT	BMC	EXS GENERAL	41 32 56 N	112 03 41 W	34	YES	SMALL COMNTY	MARKER BECN				/ 20Y
263	CANYONLAND/UT	67V	EXS GENERAL	38 11 00 N	109 44 00 W	27	YES	SMALL COMNTY	MARKER BECN				/ 18X
264	CEDAR CITY/UT	CDC	EXS AIR CARR	37 42 06 N	113 05 53 W	20	YES	SMALL COMNTY	MARKER BECN				/ 18X
265	GLENCANYON/UT	U07	EXS GENERAL	37 32 45 N	110 42 45 W	1	YES	SMALL COMNTY	MARKER BECN				/ 20X
266	LOGANCACHE/UT	LGU	EXS GENERAL	41 47 14 N	111 51 12 W	17	YES	SMALL COMNTY	MARKER BECN				/ 23Y
267	MOAB /UT	CNY	EXS AIR CARR	38 45 34 N	109 44 46 W	15	YES	SMALL COMNTY	MARKER BECN				/ 20Y
268	OGDEN MUNI/UT	OGD	EXS GENERAL	41 11 47 N	112 00 39 W	3	YES	SMALL COMNTY	MARKER BECN				/ 18X
269	PROVO MUNI/UT	PVU	EXS GENERAL	40 12 56 N	111 43 15 W	13	YES	SMALL COMNTY	MARKER BECN				/ 24X
270	PROVO MUNI/UT	PVU	EXS GENERAL	40 12 56 N	111 43 15 W	18	YES	SMALL COMNTY	MARKER BECN				/ 18Y
271	SALT LAKE /UT	SLC	EXS AIR CARR	40 47 03 N	111 58 01 W	34L	YES	BAS WIDE BAZ	P DME	2	SLC		32X/ 32X
272	SALT LAKE /UT	SLC	EXS AIR CARR	40 47 03 N	111 58 01 W	16L	YES	BAS WIDE BAZ	P DME	2	BNT		52X/ 52X
273	SALT LAKE /UT	SLC	EXS AIR CARR	40 47 03 N	111 58 01 W	14	YES	SMALL COMNTY	MARKER BECN				/ 22X
274	SALT LAKE /UT	U42	EXS GENERAL	40 37 15 N	111 59 33 W	16	YES	SMALL COMNTY	MARKER BECN				/ 19Y
275	VERNAL /UT	VEL	EXS AIR CARR	40 26 20 N	109 30 37 W	34	YES	SMALL COMNTY	MARKER BECN				/ 21Y
276	CASA GRANDE/AZ	CGC	EXS GENERAL	32 57 15 N	111 45 45 W	23	YES	SMALL COMNTY	MARKER BECN				/ 18X
277	CHANDLER /AZ	P10	EXS GENERAL	33 16 10 N	111 48 45 W	4	YES	SMALL COMNTY	MARKER BECN				/ 33Y
278	DOUGLAS /AZ	DUG	EXS AIR CARR	31 28 09 N	109 36 11 W	12	YES	SMALL COMNTY	MARKER BECN				/ 20Y
279	FLAGSTAFF /AZ	FLG	EXS AIR CARR	35 08 16 N	111 40 12 W	4	YES	SMALL COMNTY	ILS DME				/ 20Y
280	GLOBESANCA/AZ	P13	EXS GENERAL	33 21 10 N	110 39 45 W	9	YES	SMALL COMNTY	MARKER BECN				/ 23Y
281	GRAND CNYN/AZ	GCN	EXS AIR CARR	35 57 06 N	112 08 46 W	3	YES	SMALL COMNTY	ILS DME	3	GCN		26X/ 26X
282	GRAND CNYN/AZ	GCN	EXS AIR CARR	35 57 06 N	112 08 46 W	19	NO	SMALL COMNTY	MARKER BECN				/ 19Y
283	KINGMAN /AZ	IGM	EXS AIR CARR	35 15 24 N	113 56 25 W	17	YES	SMALL COMNTY	MARKER BECN				/ 28Y
284	LAKEHAVASU/AZ	LHU	EXS GENERAL	34 27 40 N	114 21 42 W	23	YES	SMALL COMNTY	MARKER BECN				/ 18X
285	LAKEHAVASU/AZ	LHU	EXS GENERAL	34 27 40 N	114 21 42 W	20	YES	SMALL COMNTY	MARKER BECN				/ 20Y
286	PHOENIX /AZ	GYR	EXS GENERAL	33 25 22 N	112 22 31 W	3	YES	SMALL COMNTY	MARKER BECN				/ 38X
287	MESA /AZ	P19	EXS GENERAL	33 26 35 N	111 43 39 W	4	YES	SMALL COMNTY	ILS DME				/ 22Y
288	MESA /AZ	P19	EXS GENERAL	33 26 35 N	111 43 39 W	12	NO	SMALL COMNTY	MARKER BECN				/ 46Y
289	NOGALES /AZ	OLS	EXS GENERAL	31 25 00 N	110 50 55 W	3	YES	SMALL COMNTY	MARKER BECN				/ 26Y
290	PAGE MUNI /AZ	PGA	EXS GENERAL	36 55 29 N	111 26 24 W	15	YES	SMALL COMNTY	MARKER BECN				/ 18Y
291	PARKER MUN/AZ	P20	EXS GENERAL	34 09 15 N	114 16 10 W	1	YES	SMALL COMNTY	MARKER BECN				/ 27Y
292	PARKER MUN/AZ	P20	EXS GENERAL	34 09 15 N	114 16 10 W	10	NO	SMALL COMNTY	MARKER BECN				/ 30Y
293	PHOENIX /AZ	PHX	EXS AIR CARR	33 26 07 N	112 00 43 W	8R	YES	BAS WIDE BAZ	P DME	2	PHX		20X/ 20X
294	PHOENIX /AZ	PHX	EXS AIR CARR	33 26 07 N	112 00 43 W	26L	YES	BAS WIDE BAZ	P DME				/ 17Z
295	PHOENIX /AZ	PHX	EXS AIR CARR	33 26 07 N	112 00 43 W	15	NO	SMALL COMNTY	MARKER BECN				/ 26Y
296	PHOENIX /AZ	E70	EXS GENERAL	33 25 35 N	112 10 04 W	17	YES	SMALL COMNTY	MARKER BECN				/ 29Y
297	PHOENIX /AZ	DVT	EXS GENERAL	33 41 13 N	112 04 57 W	7R	YES	SMALL COMNTY	MARKER BECN				/ 32X
298	PHOENIX /AZ	DVT	EXS GENERAL	33 41 13 N	112 04 57 W	14	NO	SMALL COMNTY	MARKER BECN				/ 35Y
299	PRESCOTT /AZ	PRC	EXS AIR CARR	34 39 05 N	112 25 15 W	3	YES	SMALL COMNTY	MARKER BECN				/ 21Y
300	SAFFORD /AZ	SAD	EXS GENERAL	32 51 17 N	109 38 05 W	8	YES	SMALL COMNTY	MARKER BECN				/ 24Y

TABLE D-2

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SYSTEM ID#	LOCATION CITY/STATE	FAC CALL	AIRPORT TYPE	FAC LATITUDE	FAC LONGITUDE	RUN WAY	EXIST RNWY	MLS SERVICE	DME EQUIPMENT	ILS OPT	EQUIP CALL	LINK NUM	CHANNEL OLD/NEW
301	SCOTTSDALE/AZ	SDL	EXS GENERAL	33 37 10 N	111 54 50 W	3	YES	SMALL COMNTY	MARKER BECN				/ 44X
302	TUCSON /AZ	TUS	EXS AIR CARR	32 07 06 N	110 56 35 W	11L	YES	BAS WIDE BAZ	P DME	R	TUS	19	22X/ 22X
303	TUCSON /AZ	TUS	EXS AIR CARR	32 07 06 N	110 56 35 W	29L	YES	BAS WIDE BAZ	P DME	R	TUS	19	22X/ 22X
304	TUCSON /AZ	TUS	EXS AIR CARR	32 07 06 N	110 56 35 W	3	YES	SMALL COMNTY	MARKER BECN				/ 25Y
305	TUCSON /AZ	RYN	EXS GENERAL	32 08 29 N	111 10 00 W	6L	YES	SMALL COMNTY	MARKER BECN				/ 36Y
306	TUCSON /AZ	P12	EXS GENERAL	32 16 40 N	111 00 30 W	12	YES	SMALL COMNTY	MARKER BECN				/ 34X
307	TUCSON /AZ	P12	EXS GENERAL	32 16 40 N	111 00 30 W	3	NO	SMALL COMNTY	MARKER BECN				/ 18Y
308	TUCSON /AZ		NEW GENERAL	32 11 00 N	110 57 00 W	11	NO	BASIC WIDE	P DME				/ 19Z
309	WILLCOX /AZ	P33	EXS GENERAL	32 14 39 N	109 53 36 W	3	YES	SMALL COMNTY	MARKER BECN				/ 19Y
310	WINSLOW /AZ	INW	EXS AIR CARR	35 01 20 N	110 43 20 W	11	YES	SMALL COMNTY	MARKER BECN				/ 22X
311	YUMA /AZ	YUM	EXS AIR CARR	32 39 24 N	114 36 18 W	3L	YES	BASIC WIDE	P DME	2	YUM		46X/
312	YUMA /AZ	YUM	EXS AIR CARR	32 39 24 N	114 36 18 W	21R	YES	BASIC WIDE	P DME	2	YUM		20X/ 20X
313	YUMA /AZ	YUM	EXS AIR CARR	32 39 24 N	114 36 18 W	8	YES	SMALL COMNTY	MARKER BECN				/ 24Y
314	BEALE AFB /CA	BAB	EXS MILITARY	39 08 00 N	121 26 00 W	14	YES	BAS WIDE BAZ	P DME	3	BAB		32X/
315	CASTLE AFB/CA	MER	EXS MILTARY	37 23 00 N	120 34 00 W	30	YES	BAS WIDE BAZ	P DME	2	MER	20	32X/
316	CASTLE AFB/CA	MER	EXS MILTARY	37 23 00 N	120 34 00 W	12	YES	BAS WIDE BAZ	P DME	3	AWZ	20	32X/
317	TRAVIS AFB/CA	SUU	EXS MILTARY	38 16 00 N	121 56 00 W	21	YES	BAS WIDE BAZ	P DME	2	SUU	21	38X/
318	TRAVIS AFB/CA	SUU	EXS MILTARY	38 16 00 N	121 56 00 W	3	YES	BAS WIDE BAZ	P DME	2	TXV	21	38X/
319	VANDENBURG/CA	VBG	EXS MILTARY	34 43 00 N	120 34 00 W	30	YES	BAS WIDE BAZ	P DME	2	VBG		38X/
320	EDWARDS AF/CA	EDW	EXS MILTARY	34 54 00 N	117 52 00 W	22	YES	BAS WIDE BAZ	P DME	3	EDW		38X/ 38X
321	MARCH AFB /CA	MRX	EXS MILTARY	33 53 00 N	117 16 00 W	31	YES	BAS WIDE BAZ	P DME	2	RIV		38X/
322	MC CLELLAN/CA	MCC	EXS MILTARY	38 40 00 N	121 24 00 W	16	YES	BAS WIDE BAZ	P DME	3	MCC	22	30X/
323	MC CLELLAN/CA	MCC	EXS MILTARY	38 40 00 N	121 24 00 W	34	YES	BAS WIDE BAZ	P DME	3	FKZ	22	30X/
324	MATHER AFB/CA	MHR	EXS MILTARY	38 34 00 N	121 18 00 W	22	YES	BAS WIDE BAZ	P DME	2	MHR	23	44X/ 44X
325	MATHER AFB/CA	MHR	EXS MILTARY	38 34 00 N	121 18 00 W	4	YES	BAS WIDE BAZ	P DME	3	POK	23	44X/ 44X
326	NORTON AFB/CA	SBD	EXS MILTARY	34 06 00 N	117 14 00 W	6	YES	BAS WIDE BAZ	P DME	2	SBD		30X/ 30X
327	HAMILTON /CA	SRF	EXS MILTARY	38 04 00 N	122 30 00 W	30	YES	BAS WIDE BAZ	P DME	2	SRF		34X/ 34X
328	EL TORO /CA	NZJ	EXS MILTARY	33 40 00 N	117 44 00 W	35R	YES	BAS WIDE BAZ	P DME				/ 38Z
329	DAVIS MONT/AZ	DMA	EXS MILTARY	32 10 00 N	110 53 00 W	30	YES	BAS WIDE BAZ	P DME	2	DMA		30X/ 30X
330	WILLIAMS /AZ	CHD	EXS MILTARY	33 18 00 N	111 40 00 W	30R	YES	BAS WIDE BAZ	P DME	2	CHD		40X/ 40X
331	HILL AFB /UT	HIF	EXS MILTARY	41 07 00 N	111 58 00 W	14	YES	BAS WIDE BAZ	P DME	2	HIF		36X/ 36X
332	CHINA LK /CA	NIA	EXS MILTARY	35 41 00 N	117 41 00 W	32	YES	BAS WIDE BAZ	P DME				/ 17Z
333	CROWSLAND /CA	NPC	EXS MILTARY	37 24 00 N	121 06 00 W	35	YES	BAS WIDE BAZ	P DME				/ 19Z
334	EL CENTRO /CA	NJK	EXS MILTARY	32 49 00 N	115 40 00 W	30R	YES	BAS WIDE BAZ	P DME				/ 24Z
335	FRITZSCHE /CA	OAR	EXS MILTARY	36 41 00 N	121 46 00 W	29	YES	BAS WIDE BAZ	P DME				/ 22Z
336	IMPERIAL B/CA	VCV	EXS MILTARY	34 35 00 N	117 23 00 W	16	YES	BAS WIDE BAZ	P DME				/ 32Y
337	GEORGE AFB/CA	NRS	EXS MILTARY	33 34 00 N	117 07 00 W	9	YES	BAS WIDE BAZ	P DME				/ 22Z
338	LEMOORE /CA	NLC	EXS MILTARY	36 20 00 N	119 57 00 W	32L	YES	BAS WIDE BAZ	P DME				/ 29Z
339	LIBBY AAF /AZ	FHU	EXS MILTARY	31 35 00 N	110 20 00 W	29	YES	BAS WIDE BAZ	P DME				/ 20Z
340	MOFFETT FD/CA	NUQ	EXS MILTARY	37 25 00 N	122 03 00 W	32L	YES	BAS WIDE BAZ	P DME				/ 23Z
341	NORTH ISLN/CA	NZY	EXS MILTARY	32 42 00 N	117 12 00 W	29	YES	BAS WIDE BAZ	P DME				/ 28Z
342	PT MUGU /CA	NTD	EXS MILTARY	34 07 00 N	119 07 00 W	3	YES	BAS WIDE BAZ	P DME				/ 20Z
343	SAN CLEMEN/CA	NUC	EXS MILTARY	33 01 00 N	118 35 00 W	23	YES	BAS WIDE BAZ	P DME				/ 24Z
344	SAN NICOLS/CA	NSI	EXS MILTARY	33 14 00 N	119 28 00 W	30	YES	BAS WIDE BAZ	P DME				/ 29Z
345	SANTA ANA /CA	NTK	EXS MILTARY	33 42 00 N	117 50 00 W	24	YES	BAS WIDE BAZ	P DME				/ 43Z
346	LUKE AFB /AZ	LUF	EXS MILTARY	33 33 00 N	112 22 00 W	3R	YES	BAS WIDE BAZ	P DME	R	LUF	24	24X/ 24X
347	LUKE AFB /AZ	LUF	EXS MILTARY	33 33 00 N	112 22 00 W	21L	YES	BAS WIDE BAZ	P DME	R	LUF	24	24X/ 24X
348	FALLON /NV	NFL	EXS MILTARY	39 25 00 N	118 42 30 W	31	YES	BAS WIDE BAZ	P DME				/ 20Z
349	NELLIS AFB/NV	LSV	EXS MILTARY	36 14 00 N	115 02 00 W	3R	YES	BAS WIDE BAZ	P DME	R	LSV	25	28X/ 28X
350	NELLIS AFB/NV	LSV	EXS MILTARY	36 14 00 N	115 02 00 W	21L	YES	BAS WIDE BAZ	P DME	R	LSV	25	28X/ 28X

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SYSTEM ID#	LOCATION CITY/STATE	FAC CALL	AIRPORT TYPE	FAC LATITUDE	FAC LONGITUDE	RUN WAY	EXIST RNWY	MLS SERVICE	DME EQUIPMENT	ILS OPT	EQUIP CALL	LINK NUM	CHANNEL OLD/NEW
351	DUGWAY /UT	DPG	EXS MILITARY	40 12 00 N	112 56 00 W	25	YES	BAS WIDE BAZ	P DME				/ 17Z
352	PALMDALE /CA	PMD	EXS AIR CARR	34 37 46 N	118 05 01 W	25	YES	360 EXPN BAZ	P DME	2	PMD		28X/ 28X
353	PALMDALE /CA	PMD	EXS AIR CARR	34 37 46 N	118 05 01 W	7	YES	BAS WIDE BAZ	P DME				/ 21Z
354	PALMDALE /CA	PMD	EXS AIR CARR	34 37 46 N	118 05 01 W	22	YES	BAS WIDE BAZ	P DME				/ 25Z
355	PALMDALE /CA	PMD	EXS AIR CARR	34 37 46 N	118 05 01 W	4	YES	BASIC WIDE	P DME				/ 33Z

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ENROUTE ENVIRONMENT
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SYSTEM D#	LOCATION CITY	STATE	EQUIP LATITUDE	EQUIP LONGITUDE	EQUIPMENT TYPE	SERVICE VOLUME	CALL LETTERS	CHANNEL OLD/NEW	LINK NUM
80001	GEORGEAB	CA	34 35 41 N	117 23 21 W	TACAN	LOW	VCV	23X/ 23X	
80002	BEALE	CA	39 08 06 N	121 26 23 W	TACAN	LOW	BAB	23X/ 23X	
80003	IMP BCH	CA	32 33 51 N	117 06 32 W	TACAN	LOW	NRS	29X/ 29X	
80004	MIRAMAR	CA	32 52 11 N	117 09 14 W	TACAN	LOW	NKX	33X/ 33X	
80005	EL TORO	CA	33 40 28 N	117 43 54 W	TACAN	LOW	NZJ	37X/	
80006	CRWS LND	CA	37 24 25 N	121 06 44 W	TACAN	LOW	NRZ	39X/ 39X	
80007	SNNICLIS	CA	33 14 06 N	119 27 27 W	TACAN	LOW	NSI	39X/ 39X	
80008	PT MUGU	CA	34 07 24 N	119 07 16 W	TACAN	LOW	NTD	43X/	
80009	HILL AFB	UT	41 07 14 N	111 57 46 W	TACAN	LOW	HIF	49X/ 49X	
80010	SEAL BCH	CA	33 43 50 N	118 05 10 W	TACAN	TERMINAL		49X/	
90011	CRWSLNDG	CA	37 24 40 N	121 06 33 W	TACAN	LOW		49X/	
80012	CHINA LK	CA	35 41 17 N	117 41 23 W	TACAN	LOW	NID	53X/ 53X	
80013	CPPNDLTN	CA	33 18 04 N	117 21 03 W	TACAN	TERMINAL	CCS	55X/ 55X	
80014	VANDENBG	CA	34 43 57 N	120 34 55 W	TACAN	LOW	VBG	58X/ 58X	
80015	SNCLEMNT	CA	33 01 37 N	118 34 43 W	TACAN	LOW	NUC	73X/ 73X	
80016	HAMILTON	CA	38 03 35 N	122 30 14 W	TACAN	LOW	SRF	75X/ 75X	
80017	LUKE	AZ	33 32 41 N	112 22 52 W	TACAN	LOW	LUF	77X/ 77X	
80018	MARCHAFB	CA	33 54 25 N	117 16 26 W	TACAN	LOW	RIV	77X/ 77X	
80019	ALAMEDA	CA	37 47 31 N	122 19 45 W	TACAN	LOW	NGZ	78X/ 78X	
80020	MATHERAB	CA	38 33 04 N	121 17 44 W	TACAN	LOW	MHR	81X/ 81X	
80021	FALLON	NE	39 24 59 N	118 42 10 W	TACAN	HIGH	NFL	82X/	
80022	YUMA	AZ	32 38 48 N	114 36 46 W	TACAN	LOW	NYL	84X/ 84X	
80023	DVSMNTHN	AZ	32 09 36 N	110 52 49 W	TACAN	LOW	DMA	111X/111X	
90024	TRAVISAB	CA	38 14 44 N	121 56 38 W	TACAN	LOW	SUU	113X/113X	
90025	NTHISLD	CA	32 41 53 N	117 14 05 W	TACAN	LOW	NZY	117X/117X	
90026	SNCLMNTI	CA	33 01 37 N	118 34 43 W	TACAN	LOW	NUC	123X/123X	
9002[illegible]	MOFFTFLD	CA	37 25 57 N	122 03 23 W	TACAN	LOW	NUQ	123X/123X	
900[illegible]	VERNAL	UT	40 22 44 N	109 29 33 W	VOR 1-A	LOW	VEL	19X/ 19X	
9001[illegible]	FLGSTAFF	AZ	34 36 00 N	111 40 24 W	VOR 1-A	LOW	FLG	19X/ 19X	
90015	NOGALES	AZ	31 24 54 N	110 50 54 W	VOR 1-A	TERMINAL	OLS	19X/ 19X	
90016	VENTURA	CA	34 06 54 N	119 02 55 W	VOR 1-A	LOW	VTU	19X/ 19X	
90017	LAK HUGE	CA	34 40 59 N	118 34 34 W	VOR 1-A	LOW	LHS	21X/ 21X	
90018	PROV MUN	UT	40 12 54 N	111 43 14 W	VOR 1-A	TERMINAL	PVU	21X/ 21X	
90019	GLOBE	AZ	33 22 38 N	110 43 23 W	VOR 1-A	LOW	GOB	21X/ 21X	
90020	RDIN MUN	CA	40 30 17 N	122 17 26 W	VOR 1-A	TERMINAL	RDD	21X/ 21X	
90021	CEDR MUN	UT	37 47 15 N	113 04 03 W	VOR 1-A	LOW	CDC	23X/ 23X	
90022	SANT AN	CA	33 40 01 N	117 51 43 W	VOR 1-A	TERMINAL	SNA	25X/ 25X	
90023	KINGMAN	AZ	35 15 38 N	113 56 00 W	VOR 1-A	LOW	IGM	25X/ 25X	
90024	DOUGLAS	AZ	31 28 21 N	109 36 05 W	VOR 1-A	LOW	DUG	25X/ 25X	
90025	PRICE	UT	39 36 50 N	110 44 56 W	VOR 1-A	TERMINAL	PUC	27X/ 27X	
90026	SANT MAR	CA	34 57 09 N	120 31 14 W	VOR 1-A	TERMINAL	SMX	27X/ 27X	
90027	CRESCENT	CA	41 46 47 N	124 14 23 W	VOR 1-3	LOW	CEC	27X/ 27X	
90028	FORTRVIL	CA	35 54 47 N	119 01 12 W	VOR 1-A	LOW	PTV	29X/ 29X	
90029	VISALIA	CA	36 22 03 N	119 28 52 W	VOR 1-A	TERMINAL	VIS	31X/ 31X	
90030	SNT CALA	CA	33 22 30 N	118 25 08 W	VOR 1-A	LOW	SXC	33X/	
90031	SANT ROS	CA	38 30 30 N	122 48 34 W	VOR 1-A	LOW	STS	31X/ 31X	
90032	BISHOP	CA	37 22 37 N	118 21 56 W	VOR 1-A	LOW	BIH	33X/ 33X	
90033	FT JONES	CA	41 26 59 N	122 48 19 W	VOR 1-A	LOW	FJS	33X/ 33X	
90034	LOGAN	UT	41 50 39 N	111 51 53 W	VOR 1-A	TERMINAL	LGU	35X/ 35X	
90035	MOAB	UT	38 45 23 N	109 44 55 W	VOR 1-A	TERMINAL	OAB	35X/ 35X	

AD-A093 449   IIT RESEARCH INST   ANNAPOLIS MD   F/G 17/7
MLS CHANNEL ASSIGNMENT MODEL.(U)
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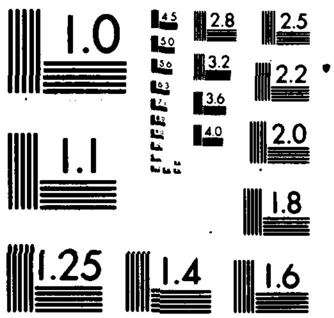

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

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SYSTEM ID#	LOCATION CITY	STATE	EQUIP LATITUDE	EQUIP LONGITUDE	EQUIPMENT TYPE	SERVICE VOLUME	CALL LETTERS	CHANNEL OLD/NEW	LINK NUM
90036	SNT GEOG	UT	37 05 17 N	113 35 30 W	VOR 1-A	TERMINAL	OZN	35X/ 35X	
90037	CHCO MUN	CA	39 47 24 N	121 50 46 W	VOR 1-A	TERMINAL	CIC	35X/ 35X	
90038	MAXWELL	CA	39 19 04 N	122 13 14 W	VOR 1-A	LOW	MXW	37X/	
90039	PRIEST	CA	36 08 26 N	120 39 50 W	VOR 1-A	LOW	ROM	37X/ 37X	
90040	ARCATA	CA	40 58 54 N	124 06 26 W	VOR 1-A	LOW	ACV	39X/ 39X	
90041	BUCKEYE	CA	33 27 12 N	112 49 26 W	VOR 1-A	LOW	BXK	43X/ 43X	
90042	ELY	NV	39 17 54 N	114 50 51 W	VOR 1-A	LOW	ELY	43X/ 43X	
90043	SNT MONC	CA	34 00 37 N	118 27 21 W	VOR 1-A	LOW	SMO	45X/	
90044	MARYSVIL	CA	39 05 56 N	121 34 19 W	VOR 1-A	TERMINAL	MYV	45X/ 45X	
90045	MONTAGUE	CA	41 47 10 N	122 27 50 W	VOR 1-A	TERMINAL	SIY	45X/ 45X	
90045	SNT MONC	CA	34 00 37 N	118 27 21 W	VOR 1-A	LOW	SMO	45X/	
90047	RIVERSID	CA	33 57 07 N	117 26 54 W	VOR 1-A	LOW	RAL	51X/	
90048	POMONA	CA	34 04 42 N	117 47 10 W	VOR 1-A	LOW	POM	41X/	
90049	FORT HUA	AZ	31 35 26 N	110 20 32 W	VOR 1-A	TERMINAL	FHU	53X/ 53X	
90050	VANDENBE	CA	34 42 56 N	120 33 30 W	VOR 1-A	LOW	VBG	55X/ 55X	
90051	PEACH SP	AZ	35 37 29 N	113 32 37 W	VOR 1-A	HIGH	PGS	57X/ 57X	
90052	MILFORD	UT	38 21 37 N	113 00 45 W	VOR 1-A	HIGH	MLF	58X/ 58X	
90053	NAPA CO	CA	38 13 46 N	122 22 19 W	VOR 1-A	LOW	APC	58X/ 58X	
90054	ONTARIO	CA	33 55 06 N	117 31 44 W	VOR 1-B	HIGH	ONT	59X/ 59X	
90055	BAT MOUN	NV	40 34 05 N	116 55 17 W	VOR 1-A	HIGH	BAM	59X/ 59X	
90056	BONNEVIL	UT	40 43 34 N	113 45 24 W	VOR 1-A	HIGH	BVL	70X/ 70X	
90057	ST JOHNS	AZ	34 25 26 N	109 08 34 W	VOR 1-A	HIGH	SJN	70X/ 70X	
90058	UKIAH MU	CA	39 03 12 N	123 16 23 W	VOR 1-A	HIGH	UKI	70X/ 70X	
90059	SAN LUIS	CA	35 15 08 N	120 45 31 W	VOR 1-A	LOW	SBP	71X/ 71X	
90060	FILLMORE	CA	34 21 24 N	118 52 49 W	VOR 1-A	LOW	FIM	72X/ 72X	
90061	WINSLOW	AZ	35 03 42 N	110 47 40 W	VOR 1-A	HIGH	INW	73X/ 73X	
90062	LOS BANO	CA	36 42 56 N	120 46 40 W	VOR 1-A	LOW	PXN	73X/ 73X	
90063	HECTOR	CA	39 47 49 N	116 27 43 W	VOR 1-A	HIGH	HEC	74X/ 74X	
90064	BRYCE CY	UT	37 41 21 N	112 18 11 W	VOR 1-A	HIGH	BCE	75X/ 75X	
90065	FRESNA T	CA	36 53 12 N	119 48 11 W	VOR 1-A	HIGH	FAT	76X/ 76X	
90066	GRND CYN	AZ	35 57 37 N	112 08 43 W	VOR 1-A	LOW	GCN	78X/ 78X	
90067	VAN NUYS	CA	34 13 24 N	118 29 27 W	VOR 1-B	LOW	VNY	78X/ 78X	
90068	DAGGETT	CA	34 57 45 N	116 34 38 W	VOR 1-A	HIGH	DAG	79X/ 79X	
90069	LAK TAHO	CA	39 10 50 N	120 16 07 W	VOR 1-A	LOW	LTA	79X/ 79X	
90070	CHANDLER	AZ	33 18 11 N	111 39 03 W	VOR 1-A	LOW	CHD	80X/ 80X	
90071	MARCH AF	CA	33 46 31 N	117 11 17 W	VOR 1-A	TERMINAL	RIV	81X/	
90072	TUBA CIT	AZ	36 07 17 N	111 16 08 W	VOR 1-A	HIGH	TBC	82X/ 82X	
90073	L A INTL	CA	33 55 59 N	118 25 52 W	VOR 1-A	HIGH	LAX	83X/ 83X	
90074	LUCIN	UT	41 21 47 N	113 50 23 W	VOR 1-A	HIGH	LCU	83X/ 83X	
90075	PT REYES	CA	38 04 47 N	122 52 00 W	VOR 1-B	LOW	PYE	84X/ 84X	
90076	WOODSIDE	CA	37 23 33 N	122 16 49 W	VOR 1-B	LOW	OSI	86X/ 86X	
90077	JULIAN	CA	33 08 26 N	116 35 06 W	VOR 1-A	LOW	JLI	87X/ 87X	
90078	BIG SUR	CA	36 10 53 N	121 38 28 W	VOR 1-A	LOW	BSR	87X/ 87X	
90079	FORTUNA	CA	40 40 17 N	124 14 00 W	VOR 1-A	LOW	FOT	87X/ 87X	
90080	PSCOT MU	AZ	34 42 09 N	112 28 46 W	VOR 1-A	HIGH	PRC	88X/ 88X	
90081	HAZEN	NV	39 30 59 N	118 59 48 W	VOR 1-A	LOW	HZN	88X/ 88X	
90082	SN JOS M	CA	37 21 53 N	121 55 45 W	VOR 1-A	LOW	SJC	88X/ 88X	
90083	TWIN PLM	CA	34 06 44 N	115 46 09 W	VOR 1-A	LOW	TNP	89X/ 89X	
90084	WELLS	NV	41 06 42 N	114 58 36 W	VOR 1-A	LOW	LWL	89X/ 89X	
90085	MERCED	CA	37 13 10 N	120 23 57 W	VOR 1-A	LOW	MCE	89X/ 89X	

TABLE D-3

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SYSTEM D#	LOCATION CITY	STATE	EQUIP LATITUDE	EQUIP LONGITUDE	EQUIPMENT TYPE	SERVICE VOLUME	CALL LETTERS	CHANNEL OLD/NEW	LINK NUP
90086	SOD HOUS	NV	41 24 38 N	118 01 56 W	VOR 1-A	LOW	SDO	90X/ 90X	
90087	MORMN MS	NV	36 46 10 N	114 16 36 W	VOR 1-A	LOW	MMM	90X/ 90X	
90088	PASO R M	CA	35 40 21 N	120 37 34 W	VOR 1-A	LOW	PRB	90X/ 90X	
90089	GOFFS	CA	35 07 52 N	115 10 32 W	VOR 1-A	LOW	GFS	91X/ 91X	
90090	WILLIAMS	CA	39 04 16 N	122 01 34 W	VOR 1-A	LOW	ILA	91X/ 91X	
90091	PALMDALE	CA	34 37 53 N	118 03 47 W	VOR 1-A	HIGH	PMD	92X/ 92X	
90092	ELKO MUN	NV	40 45 35 N	115 45 38 W	VOR 1-A	LOW	EKO	92X/ 92X	
90093	MDST-C-C	CA	37 37 39 N	120 57 24 W	VOR 1-A	HIGH	MOD	93X/ 93X	
90094	BEATTY	NV	36 48 02 N	116 44 48 W	VOR 1-A	HIGH	BTY	94X/ 94X	
90095	CAS GRND	AZ	32 53 09 N	111 54 29 W	VOR 1-A	HIGH	CZG	95X/ 95X	
90096	LINDED	CA	38 04 29 N	121 00 10 W	VOR 1-A	HIGH	LIN	95X/ 95X	
90097	SNT BA M	CA	39 30 35 N	119 46 12 W	VOR 1-A	HIGH	SBA	96X/ 96X	
90098	MINA	NV	38 33 55 N	118 01 55 W	VOR 1-A	HIGH	MVA	98X/ 98X	
90099	SACRAM X	CA	38 26 35 N	121 33 02 W	VOR 1-A	HIGH	SAC	99X/ 99X	
90100	NEEDLE M	CA	34 45 53 N	114 28 24 W	VOR 1-A	HIGH	EED	99X/ 99X	
90101	OCEANSID	CA	33 14 26 N	117 25 01 W	VOR 1-A	HIGH	OCN	100X/100X	
90102	SAN SIMO	AZ	32 16 29 N	109 15 45 W	VOR 1-A	HIGH	SSO	101X/101X	
90103	BAKERFLD	CA	35 29 05 N	119 05 47 W	VOR 1-A	HIGH	BFL	101X/101X	
90104	PLM SPR	CA	33 52 12 N	116 25 44 W	VOR 1-A	LOW	PSP	102X/102X	
90105	FRIANT	CA	37 06 16 N	119 35 40 W	VOR 1-A	LOW	FRA	103X/103X	
90106	PHX S MB	AZ	33 25 53 N	111 53 17 W	VOR 1-B	HIGH	PHX	103X/103X	
90107	SEAL BCH	CA	33 47 00 N	118 03 14 W	VOR 1-A	LOW	SLI	104X/104X	
90108	OGDEN MU	UT	41 13 27 N	112 05 51 W	VOR 1-A	LOW	OGD	104X/104X	
90109	RED BUF	CA	40 05 57 N	122 14 07 W	VOR 1-A	HIGH	RBL	104X/104X	
90110	S F INTL	CA	37 36 59 N	122 21 23 W	VOR 1-A	LOW	SFO	105X/105X	
90111	COCHISE	AZ	32 02 00 N	109 45 27 W	VOR 1-A	HIGH	CIE	105X/105X	
90112	S F INTL	CA	37 37 10 N	122 22 22 W	VOR 1-A	HIGH	SFO	105X/	
90113	CAMARILO	CA	34 12 45 N	119 05 36 W	VOR 1-A	LOW	CMA	105X/105X	
90114	IMPERIAL	CA	32 44 56 N	115 30 28 W	VOR 1-A	HIGH	IPL	106X/106X	
90115	HANKSVIL	UT	38 25 01 N	110 41 56 W	VOR 1-A	HIGH	HVE	106X/106X	
90116	STRTN ME	CA	37 50 01 N	121 10 13 W	VOR 1-A	HIGH	SCK	107X/	
90117	GORMAN	CA	34 46 15 N	118 51 38 W	VOR 1-A	LOW	GMN	106X/109X	
90118	DELTA MU	UT	39 18 09 N	112 30 17 W	VOR 1-A	HIGH	DTA	108X/108X	
90119	THERMAL	CA	33 37 41 N	116 09 34 W	VOR 1-A	HIGH	TRM	109X/109X	
90120	SAUSALIT	CA	37 51 19 N	122 31 18 W	VOR 1-A	LOW	SAU	109X/109X	
90121	WILSN CK	NV	38 15 01 N	114 23 36 W	VOR 1-A	HIGH	ILC	110X/110X	
90122	EDWR AFB	CA	34 58 57 N	117 43 54 W	VOR 1-A	LOW	EDW	110X/	
90123	TRAVIS A	CA	38 20 41 N	121 48 35 W	VOR 1-A	LOW	SUU	111X/	
90124	LOVELOCK	NV	40 04 00 N	118 33 36 W	VOR 1-A	LOW	LOL	112X/112X	
90125	GAVIOTA	CA	34 31 53 N	120 05 24 W	VOR 1-A	LOW	GVO	112X/112X	
90126	FAIRFILD	UT	40 16 30 N	111 56 23 W	VOR 1-A	LOW	FFU	113X/113X	
90127	GILA BEN	AZ	32 57 22 N	112 40 25 W	VOR 1-A	HIGH	GBN	113X/113X	
90128	BOLDR CI	NV	35 59 45 N	114 51 46 W	VOR 1-A	HIGH	BLD	114X/114X	
90129	YUMA	AZ	32 49 05 N	114 36 08 W	VOR 1-A	HIGH	YUM	115X/115X	
90130	S LAK CI	UT	40 51 01 N	111 58 52 W	VOR 1-A	HIGH	SLC	115X/115X	
90131	OAKLAND	CA	37 43 34 N	122 13 21 W	VOR 1-A	HIGH	OAK	115X/115X	
90132	LAS BEGA	NV	36 04 47 N	115 09 32 W	VOR 1-A	HIGH	LAS	116X/116X	
90133	CONCORD	CA	38 02 42 N	122 02 39 W	VOR 1-A	TERMINAL	CCR	117X/	
90134	TUSON IN	AZ	32 07 21 N	110 49 12 W	VOR 1-A	HIGH	TUS	118X/118X	
90135	AVENAL	CA	35 38 49 N	119 58 39 W	VOR 1-A	HIGH	AVE	118X/118X	

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SYSTEM DB	LOCATION CITY	STATE	EQUIP LATITUDE	EQUIP LONGITUDE	EQUIPMENT TYPE	SERVICE VOLUME	CALL LETTERS	CHANNEL OLD/NEW	LINK NUM
90136	TONOPAH	NV	38 01 51 N	117 01 57 W	VOR 1-A	LOW	TPH	119X/119X	
90137	EL TORO	CA	33 40 03 N	117 43 50 W	VOR 1-A	LOW	NZJ	119X/119X	
90138	SALIN MU	CA	36 39 50 N	121 36 08 W	VOR 1-A	HIGH	SNS	120X/120X	
90139	BLYTHE	CA	33 35 46 N	114 45 37 W	VOR 1-A	HIGH	BLH	121X/121X	
90140	FELLOWS	CA	35 05 35 N	119 51 53 W	VOR 1-A	LOW	FLW	122X/122X	
90141	PAGE	AZ	36 55 41 N	111 27 00 W	VOR 1-A	TERMINAL	PGA	123X/123X	
90142	COALDALE	NV	38 00 12 N	117 46 10 W	VOR 1-A	HIGH	OAL	124X/124X	
90143	MISN BAY	CA	32 46 55 N	117 13 28 W	VOR 1-A	HIGH	MZB	125X/125X	
90144	MYTON	UT	40 08 40 N	110 07 37 W	VOR 1-A	HIGH	MTU	126X/126X	
90145	PARKER	CA	39 06 07 N	114 40 52 W	VOR 1-A	HIGH	PKE	126X/126X	
90146	RENO INT	NV	39 31 53 N	119 39 18 W	VOR 1-A	HIGH	RNO	126X/126X	
90147	BEALE	CA	39 17 46 N	121 30 32 W	VOR 1-A	LOW	BAB	25X/	
90148	SIERRDPT	CA	40 15 00 N	120 39 00 W	VOR 1-A	LOW		27X/ 27X	
90149	MCCLELLN	CA	38 40 03 N	121 24 12 W	VOR 1-A	LOW	MCC	29X/ 29X	
90150	VISALIA	CA	36 22 03 N	119 28 52 W	VOR 1-A	TERMINAL	VIS	31X/ 31X	
90151	SANTAMAR	CA	34 57 09 N	120 31 14 W	VOR 1-A	TERMINAL	SMX	47X/ 47X	
90152	FT ORD	CA	36 41 00 N	121 46 00 W	VOR 1-A	LOW	FTO	72X/ 72X	
90153	SANTAROS	CA	38 30 30 N	122 48 34 W	VOR 1-A	LOW	STS	77X/	
90154	LEMOORE	CA	36 02 39 N	119 57 55 W	VOR 1-A	LOW	NLC	80X/ 80X	
90155	PLACRVLL	CA	38 43 27 N	120 44 57 W	VOR 1-A	LOW	PLC	102X/102X	

APPENDIX E

CHANNEL PLAN

This appendix contains a listing of the channel plan used in the initial assignment attempt.

TABLE E-1

CHANNEL PLAN
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Channel	C-Band (MHz)	L-Band (MHz)	L-Band (MHz)	VHF (MHz)	UHF (MHz)
17X	-	-	978	108.00	-
17Y	5031.0	1104	1104	108.05	-
17XZ	5031.3	978	-	-	-
18X	5031.6	979	979	108.10	334.10
18Y	5031.9	1105	1105	108.15	334.55
18XZ	5032.2	979	-	-	-
19X	-	-	980	108.20	-
19Y	5032.5	1106	1106	108.25	-
19XZ	5032.8	980	-	-	-
20X	5033.1	981	981	108.30	334.10
20Y	5033.4	1107	1107	108.35	334.95
20XZ	5033.7	981	-	-	-
21X	-	-	982	108.40	-
21Y	5034.0	1108	1108	108.45	-
21XZ	5034.3	982	-	-	-
22X	5034.6	983	983	108.50	329.90
22Y	5034.9	1109	1109	108.55	329.75
22XZ	5035.2	983	-	-	-
23X	-	-	984	108.66	-
23Y	5035.5	1110	1110	108.65	-
23XZ	5035.8	984	-	-	-
24X	5036.1	985	985	108.70	330.50
24Y	5036.4	1111	1111	108.75	330.35
24XZ	5036.7	985	-	-	-
25X	-	-	986	108.80	-
25Y	5037.0	1112	1112	108.85	-
25XZ	5037.3	986	-	-	-
26X	5037.6	987	987	108.90	329.30
26Y	5037.9	1113	1113	108.95	329.15
26XZ	5038.2	987	-	-	-
27X	-	-	988	109.00	-
27Y	5038.5	1114	1114	109.05	-
27XZ	5038.8	988	-	-	-
28X	5039.1	989	989	109.10	331.40
28Y	5039.4	1115	1115	109.15	331.25
28XZ	5039.7	989	-	-	-
29X	-	-	990	109.20	-
29Y	5040.0	1116	1116	109.25	-
29XZ	5040.3	990	-	-	-
30X	5040.6	991	991	109.30	332.00
30Y	5040.9	1117	1117	109.35	331.85
30XZ	5041.2	991	-	-	-

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Channel	C-Band (MHz)	L-Band (MHz)	L-Band (MHz)	VHF (MHz)	UHF (MHz)
31X	-	-	992	109.40	-
31Y	5041.5	1118	1118	109.45	-
31XZ	5041.8	992	-	-	-
32X	5042.1	993	993	109.50	332.60
32Y	5042.4	1119	1119	109.55	332.45
32XZ	5042.7	993	-	-	-
33X	-	-	994	109.60	-
33Y	5043.0	1120	1120	109.65	-
33XZ	5043.3	994	-	-	-
34X	5043.6	995	995	109.70	333.20
34Y	5043.9	1121	1121	109.75	333.05
34XZ	5044.2	995	-	-	-
35X	-	-	996	109.80	-
35Y	5044.5	1122	1122	109.85	-
35XZ	5044.8	991	-	-	-
36X	5045.1	997	997	109.90	333.80
36Y	5045.4	1123	1123	109.95	333.65
36XZ	5045.7	997	-	-	-
37X	-	-	998	110.00	-
37Y	5046.0	1124	1124	110.05	-
37XZ	5046.3	998	-	-	-
38X	5046.6	999	999	110.10	334.40
38Y	5046.9	1125	1125	110.15	334.25
38XZ	5047.2	999	-	-	-
39X	-	-	1000	110.20	-
39Y	5047.5	1126	1126	110.25	-
39XZ	5047.8	1000	-	-	-
40X	5048.1	1001	1001	110.30	335.00
40Y	5048.4	1127	1127	110.35	334.85
40XZ	5048.4	1001	-	-	-
41X	-	-	1002	110.40	-
41Y	5049.0	1128	1128	110.45	-
41XZ	5049.3	1002	-	-	-
42X	5049.6	1003	1003	110.50	329.60
42Y	5049.9	1129	1129	110.55	329.45
42XZ	5050.2	1003	-	-	-
43X	-	-	1004	110.60	-
43Y	5050.5	1130	1130	110.65	-
43XZ	5050.8	1004	-	-	-
44X	5051.1	1005	1005	110.70	330.20
44Y	5051.4	1131	1131	110.75	330.05
44XZ	5051.7	1005	-	-	-

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Channel	C-Band (MHz)	L-Band (MHz)	L-Band (MHz)	VHF (MHz)	UHF (MHz)
45X	-	-	1006	110.80	-
45Y	5052.0	1132	1132	110.85	-
45XZ	5052.3	1006	-	-	-
46X	5052.6	1007	1007	110.90	330.80
46Y	5052.9	1133	1133	110.95	330.65
46XZ	5053.2	1007	-	-	-
47X	-	-	1008	111.00	-
47Y	-	-	1134	111.05	-
47XZ	5053.5	1008	-	-	-
48X	5053.8	1009	1009	111.10	331.70
48Y	5054.1	1135	1135	111.15	331.55
48XZ	5054.4	1009	-	-	-
49X	-	-	1010	111.20	-
49Y	-	-	1136	111.25	-
49XZ	5054.7	1010	-	-	-
50X	5055.0	1011	1011	111.30	332.30
50Y	5055.3	1137	1137	111.35	332.15
50XZ	5055.6	1011	-	-	-
51X	-	-	1012	111.40	-
51Y	-	-	1138	111.45	-
51XZ	5055.9	1012	-	-	-
52X	5056.2	1013	1013	111.50	332.90
52Y	5056.5	1139	1139	111.55	332.75
52XZ	5056.8	1013	-	-	-
53X	-	-	1014	111.60	-
53Y	-	-	1014	111.65	-
53XZ	5057.1	1014	-	-	-
54X	5057.4	1015	1015	111.70	333.50
54Y	5057.7	1141	1141	111.75	333.35
54XZ	5058.0	1015	-	-	-
55X	-	-	1016	111.80	-
55Y	-	-	1142	111.85	-
55XZ	5058.3	1016	-	-	-
56X	5058.6	1017	1017	111.90	331.90
56Y	5058.9	1143	1143	111.95	330.95
56XZ	5059.2	1017	-	-	-
57X	-	-	1018	112.00	-
57Y	-	-	1144	112.05	-
57XZ	5059.5	1018	-	-	-
58X	-	-	1019	112.10	-
58Y	-	-	1145	112.15	-
58XZ	5059.8	1019	-	-	-
59X	-	-	1020	112.20	-
59Y	-	-	1146	112.25	-
59XZ	5060.1	1020	-	-	-

TABLE E-1

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Channel	C-Band (MHz)	L-Band (MHz)	L-Band (MHz)	VHF (MHz)	UHF (MHz)
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70X	-	-	1157	112.30	-
70Y	-	-	1031	112.35	-
71X	-	-	1158	112.40	
71Y	-	-	1032	112.45	
72X	-	-	1159	112.50	
72Y	-	-	1033	112.55	
72XZ	5060.4	1159	-	-	-
73X	-	-	1160	112.60	-
73Y	-	-	1034	112.65	
73XZ	5060.7	1160	-	-	-
74X	-	-	1161	112.70	-
74Y	-	-	1035	112.75	-
74XZ	5061.0	1161	-	-	-
75X	-	-	1162	112.80	-
75Y	-	-	1036	112.85	-
75XZ	5061.3	1162	-	-	-
76X	-	-	1163	112.90	-
76Y	-	-	1037	112.95	-
76XZ	5061.6	1163	-	-	-
77X	-	-	1164	113.00	-
77Y	-	-	1038	113.05	-
77XZ	5061.9	1164	-	-	-
78X	-	-	1165	113.10	-
78Y	5062.2	1039	1039	113.15	-
78XZ	5062.5	1165	-	-	-
79X	-	-	1166	113.20	-
79Y	5062.8	1040	1166	113.20	-
79XZ	5063.1	1166	-	-	-
80X	-	-	1167	113.30	-
80Y	5063.4	1041	1041	113.35	-
80XZ	5063.7	1167	-	-	-
81X	-	-	1168	113.40	-
81Y	5064.0	1042	1042	113.45	-
81XZ	5064.3	1168	-	-	-
82X	-	-	1169	113.50	-
82Y	5064.6	1043	1043	113.55	-
82XZ	5064.9	1169	-	-	-
83X	-	-	1170	113.60	-
83Y	5065.2	1044	1044	113.65	-
83XZ	5065.5	1170	-	-	-

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Channel	C-Band (MHz)	L-Band (MHz)	L-Band (MHz)	VHF (MHz)	UHF (MHz)
84X	-	-	1171	113.70	-
84Y	5065.8	1045	1045	113.75	-
84XZ	5066.1	1171	-	-	-
85X	-	-	1172	113.80	-
85Y	5066.4	1046	1046	113.85	-
85XZ	5066.7	1172	-	-	-
86X	-	-	1173	113.90	-
86Y	5067.0	1047	1047	113.95	-
86XZ	5067.3	1173	-	-	-
87X	-	-	1174	114.00	-
87Y	5067.6	1048	1048	114.05	-
87XZ	5067.9	1174	-	-	-
88X	-	-	1175	114.10	-
88Y	5068.2	1049	1049	114.15	-
88XZ	5068.5	1175	-	-	-
89X	-	-	1176	114.20	-
89Y	5068.8	1050	1050	114.25	-
89XZ	5069.1	1176	-	-	-
90X	-	-	1177	114.30	-
90Y	5069.4	1051	1051	114.35	-
90XZ	5069.7	1177	-	-	-
91X	-	-	1178	114.40	-
91Y	5070.0	1052	1052	114.45	-
91XZ	5070.3	1178	-	-	-
92X	-	-	1179	114.50	-
92Y	5070.6	1053	1053	114.55	-
92XZ	5070.9	1179	-	-	-
93X	-	-	1180	114.60	-
93Y	5070.2	1054	1054	114.65	-
93XZ	5070.5	1180	-	-	-
94X	-	-	1181	114.70	-
94Y	5071.8	1055	1055	114.75	-
94XZ	5072.1	1181	-	-	-
95X	-	-	1182	114.80	-
95Y	5072.4	1056	1056	114.85	-
95XZ	5072.7	1182	-	-	-
96X	-	-	1183	114.90	-
96Y	5073.0	1057	1057	114.90	-
96XZ	5073.3	1183	-	-	-
97X	-	-	1184	115.00	-
97Y	5073.6	1058	1058	115.05	-
97XZ	5073.9	1184	-	-	-
98X	-	-	1185	115.10	-
98Y	5074.2	1059	1059	115.15	-
98XZ	5074.5	1185	-	-	-

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Channel	C-Band (MHz)	L-Band (MHz)	L-Band (MHz)	VHF (MHz)	UHF (MHz)
99X	-	-	1186	115.20	-
99Y	5074.8	1060	1060	115.25	-
99XZ	5075.1	1186	-	-	-
100X	-	-	1187	115.30	-
100Y	5075.4	1061	1061	115.35	-
100XZ	5075.7	1187	-	-	-
101X	-	-	1188	115.40	-
101Y	5076.0	1062	1062	115.45	-
101XZ	5076.3	1188	-	-	-
102X	-	-	1189	115.50	-
102Y	5076.6	1063	1063	115.55	-
102XZ	5076.9	1189	-	-	-
103X	-	-	1190	115.60	-
103Y	5077.2	1064	1064	115.65	-
103XZ	5077.5	1190	-	-	-
104X	-	-	1191	115.70	-
104Y	5077.8	1065	1065	115.75	-
104XZ	5078.1	1191	-	-	-
105X	-	-	1192	115.80	-
105Y	5078.4	1066	1066	115.85	-
105XZ	5078.7	1192	-	-	-
106X	-	-	1193	115.90	-
106Y	5079.0	1067	1067	115.95	-
106XZ	5079.3	1193	-	-	-
107X	-	-	1194	116.00	-
107Y	5079.6	1068	1068	116.05	-
107XZ	5079.9	1194	-	-	-
108X	-	-	1195	116.10	-
108Y	5080.2	1069	1069	116.15	-
108XZ	5080.5	1195	-	-	-
109X	-	-	1196	116.20	-
109Y	5080.8	1070	1070	116.20	-
109XZ	5081.1	1196	-	-	-
110X	-	-	1197	116.30	-
110Y	5081.4	1071	1071	116.35	-
110XZ	5081.7	1197	-	-	-
111X	-	-	1198	116.40	
111Y	5082.0	1072	1072	116.45	-
111XZ	5082.3	1198	-	-	-
112X	-	-	1199	116.50	-
112Y	5082.6	1073	1073	116.55	-
112XZ	5082.9	1199	-	-	-

TABLE E-1

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Channel	C-Band (MHz)	L-Band (MHz)	L-Band (MHz)	VHF (MHz)	UHF (MHz)
113X	-	-	1200	116.60	-
113Y	5083.2	1074	1074	116.65	-
113XZ	5083.5	1200	-	-	-
114X	-	-	1201	116.70	-
114Y	5083.8	1075	1075	116.75	-
114XZ	5084.1	1201	-	-	-
115X	-	-	1202	116.80	-
115Y	5084.4	1076	1076	116.85	-
115XZ	5084.7	1202	-	-	-
116X	-	-	1203	116.90	-
116Y	5085.0	1077	1077	116.95	
116XZ	5085.3	1203	-	-	-
117X	-	-	1204	117.00	-
117Y	5085.6	1078	1078	117.05	-
117XZ	5085.9	1204	-	-	-
118X	-	-	1205	117.10	-
118Y	5086.2	1079	1079	117.15	-
118XZ	5086.5	1205	-	-	-
119X	-	-	1206	117.20	-
119Y	5086.8	1080	1080	117.25	-
119XZ	5087.1	1206	-	-	-
120X	-	-	1207	117.30	-
120Y	5087.4	1081	1081	117.35	-
120XZ	5087.7	1207	-	-	-
121X	-	-	1208	117.40	-
121Y	5088.0	1082	1082	117.45	-
121XZ	5088.3	1208	-	-	-
122X	-	-	1209	117.50	-
122Y	5088.6	1083	1083	117.55	-
122XZ	5088.9	1209	-	-	-
123X	-	-	1210	117.60	-
123Y	5089.2	1084	1084	117.65	-
123XZ	5089.5	1210	-	-	-
124X	-	-	1211	117.70	-
124Y	5089.8	1085	1085	117.75	-
124XZ	5090.1	1211	-	-	-
125X	-	-	1212	117.80	-
125Y	-	-	1086	117.85	-
125XZ	5090.4	1212	-	-	-
126X	-	-	1213	117.90	-
126Y	-	-	1087	117.95	-
126XZ	5090.7	1213	-	-	-

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